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Agamospermy in Spiranthes cernua

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Spiranthes cernua has long been known to exhibit a high degree of polyembryony, ever since Leavitt (1900, 1901) reported the general occurrence of more than one embryo per seed. However, his observations were limited and hence do not embody any detailed information about the origin of the additional embryos. Furthermore, he did not study the development of the gametophytes, which is an essential requisite for a clear understanding of the phenomenon of polyembryony. In 1914, Pace published an account of the development of the male and female gametophytes and concluded that "the embryo sac is very irregular in its development." Her observations were not extended to post-fertilization development. Some of her findings are so unusual that they are not readily accepted by other students. Recently Maheshwari (1946) has questioned her results. Obviously relying upon Leavitt's papers, Schnarf (1929) considered the plant to be an apomict. On the other hand, in the opinion of Stebbins (1941), *S. cernua* is one of those species in which the evidence of apomixis "is either disproved or needs confirmation."

It seemed to me that a reinvestigation of the entire life cycle of this species would help to clear up some of these controversial opinions. The material for study was first collected from several localities in Massachusetts. Each collection was sectioned and studied separately. Soon it became apparent that certain individuals suggested an apomictic life cycle while others conformed to the normal sexual method. Realizing the importance of examining more material from other regions, further collections were secured from different localities in the states of Massachusetts, Rhode Island, Connecticut, Hew Hampshire, Michigan, Wisconsin and Pennsylvania. Study of this material indicates the existence of two well defined races—sexual and asexual—and also of individuals that behave in an "intermediate" manner.

Observations

Sexual individuals

Pollen.—The development of the pollen grains and male gametes does not differ from that of the method described for orchids (Swamy, 1948). Hence only a brief summary of the salient features may be given as follows: The microspore mother cells divide in a simultaneous manner to form tetrahedral or tetragonal microspore tetrads. The individual microspores of a tetrad do not separate from one another

but function as a "compound pollen grain" (Figs 1–4). The nucleus of the microspore occupies a central position in the cell (Fig. 1). Before embarking upon the next division, it moves towards the exterior side of the tetrad (Fig. 2). The division results in a smaller, darkly staining generative cell that is situated towards the exterior side, and a larger, less densely staining vegetative cell (Fig. 3). The cell membrane that is deposited during this division soon disappears, and finally the generative cell comes to lie inside the cytoplasm of the vegetative cell (Fig. 4). The pollen grains are shed at this two-celled stage.

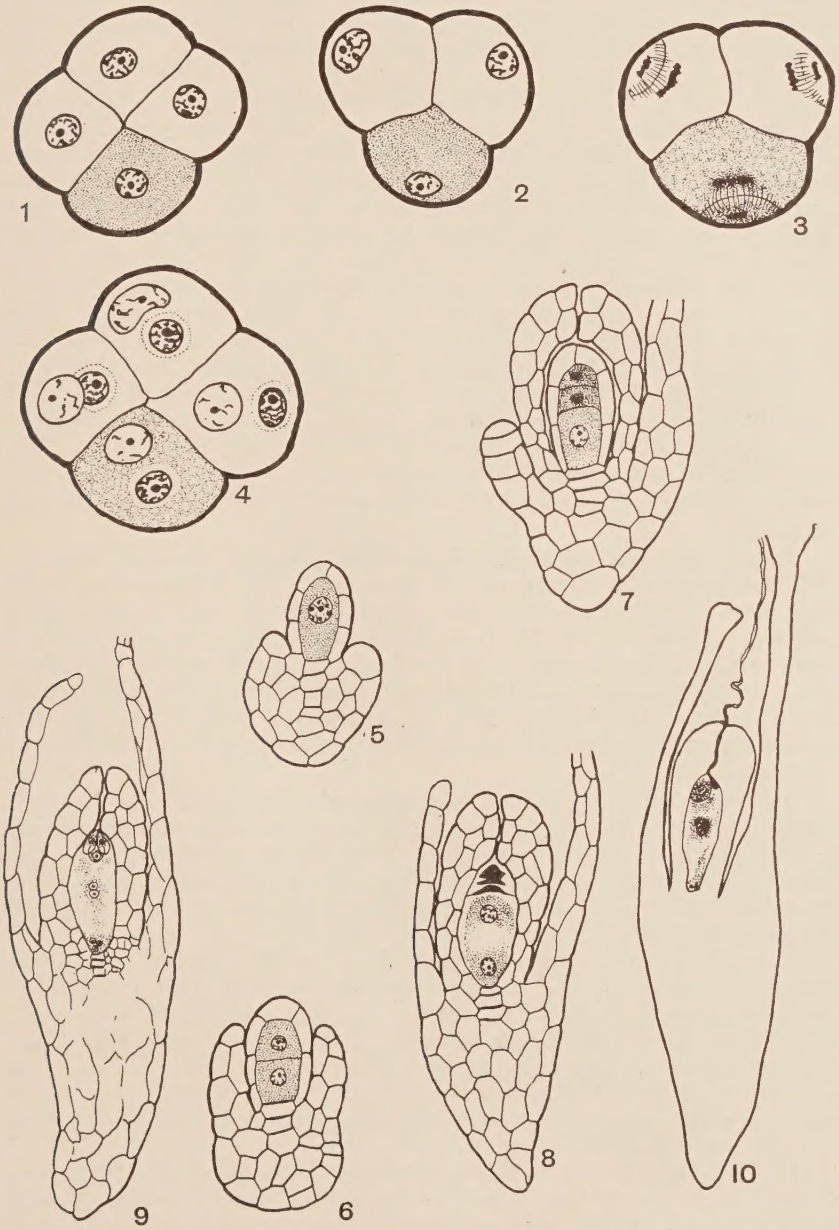
Ovule and embryo sac.—The structure of the ovule is typically of the orchid type. The nucellus consists of an axial row of five to seven cells, all covered by the nucellar epidermis. The terminal cell of the axial row differentiates as the archesporial cell, which directly functions as the megaspore mother cell (Fig. 5). The inner integument originates first and consists of two layers of cells for the greater part of its length, but in the region of the micropyle may be of three cell layers. The organization of the inner integument is complete by the time the megaspores are formed (Fig. 7). The outer integument originates slightly later (Fig. 7). Usually it consists of a single layer of cells but occasionally it may show two layers here and there. Its development becomes completed simultaneously with the maturation of the embryo sac (Fig. 9).

The megaspore mother cell (Fig. 5) gives rise to the dyad cells (Fig. 6) after the first meiotic division. The micropylar dyad cell quite often fails to complete the second division, in which case it begins prompt degeneration; the lower dyad cell, however, divides to form two megaspores (Fig. 7). The chalazal megaspore develops into the eight-nucleate embryo sac (Figs. 8, 9). The antipodal nuclei often appear diminished in size.

The pollen grain germinates on the stigma and the generative nucleus divides into two gametes in the pollen tube. The latter reaches the embryo sac through the micropyle (Fig. 10) and discharges the gametes. During this process, one of the synergids becomes disorganized. Double fertilization is accomplished in a normal manner (Fig. 10). The primary endosperm nucleus degenerates without undergoing division.

Embryo.—The first division in the zygote (Fig. 11) is by a transverse wall (Fig. 12). The basal cell divides again by another wall in the same plane (Fig. 13) so that a row of three cells is formed (Fig. 14). The division in the terminal cell is by a vertical wall (Figs. 15, 16). The subsequent divisions in the middle as well as in the terminal cells of the three-celled proembryo (Fig. 14) take place without definite temporal or spatial relationships. Thus an undifferentiated mass of cells is produced (Figs. 17–23). In the mature embryo, the cells at the micropylar half are larger (Fig. 24).

However, it may be noted that all three cells of the stage represented in Fig. 14, do not divide at the same rate to produce the mature embryo. The largest number of cells are contributed by the terminal cell; a lower number by the middle cell; and only a few cells by the basal cell. In those orchid embryos that have a suspensor, the latter cell differentiates as a morphologically distinct structure (Swamy,



FIGS. 1–10. 1–4. Stages in the development of the pollen grain. 5. Megaspore mother cell. 6. Dyad cells. 7. Ovule at the time of formation of megaspores. 8. Two-nucleate embryo sac. 9. Ovule at the time of fertilization, showing the fully mature embryo sac. 10. Ovule soon after fertilization. Note the zygote, the primary endosperm nucleus and the persisting pollen tube. All figures, × 572.

1948 a). But in the present instance, it undergoes a few divisions (Fig. 21), the resulting cells merging with the cells of the embryo proper. Hence the development of a suspensor is suppressed.

ASEXUAL INDIVIDUALS

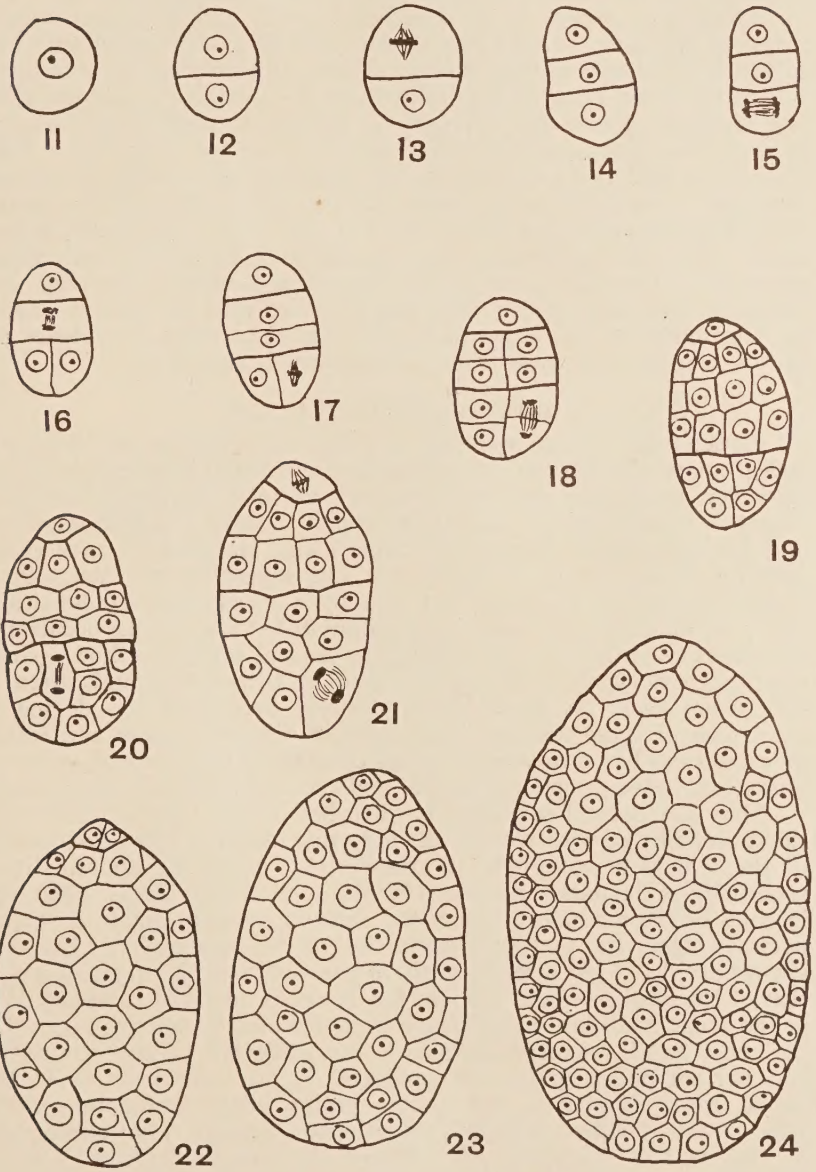
Female gametophyte.—The structure of the young ovule at the commencement of sporogenesis does not differ from that of the sexual individuals. Furthermore, up to the four-nucleate stage, the development of the embryo sac proceeds in an essentially similar manner (Figs. 25–28). After this stage, the further development becomes arrested. Very occasionally, an embryo sac with more than four nuclei was encountered among several hundreds of ovules examined. However, such instances show only abnormal organization, the anomalies pertaining either to a difference in the size of the individual nuclei, or to the pattern of their location which affect the polarity of the embryo sac, or to both. A variety of abnormalities of this kind has been noted by Pace (1914) in her material, and it suffices to mention that in my material also many of them were seen frequently. The final result of the arrested four-nucleate embryo sac or of the abnormalities in its development is the total suppression of the female sexual cycle.

Pollen.—In contrast to the female gametophyte, the development of pollen presents a normal course of events. The microspores of the compound grain attain the two-celled shedding stage long before anthesis. However, by the time the flower opens, the entire pollen mass will have degenerated and dried up within the anther. Furthermore, when the degenerated pollen is removed from opened flowers, it shows profuse infestation with a saprophytic fungus. Thus, the pollen, although normally and fully developed, becomes functionless at maturity.

Adventive embryony.—This phenomenon, associated with a high degree of polyembryony, replaces the sexual method of propagation in the plants under consideration. The inner integument, as has already been stated, is made up of two to three layers of cells. The innermost cell layer exhibits a remarkable potentiality for continued cell divisions and gives rise to the adventive embryos.

Even at as early a stage as when the megaspore mother cell is just undergoing the prophasic stages of meiosis, the innermost cells of the inner integument show more deeply staining protoplasts and larger nuclei than the remainder of its cells. Keeping pace with the megaspore mother cell, they enlarge and begin to divide (Figs. 25–34). An embryo may owe its origin to a single cell of the integument or to a group of cells. The mature seed contains generally two to six embryos that are variously located.

It is interesting to note that when a terminal cell of the integument is involved in the process, it first undergoes enormous enlargement and flares out beyond the outer integument into the cavity of the ovary. The distal end of the cell widens so much that the entire cell appears club-shaped (Figs. 30, 35). The divisions of its nucleus usually commence late in comparison with those of the others. However, subsequent divisions occur rapidly and a mass of cells, similar to the other



FIGS. 11–24. 11–23. Stages in the development of the embryo from the zygote. Explanation in text. All figures, × 900. 24. Longitudinal section of a mature embryo, × 400.

embryos, is organized. Such embryos obviously develop outside the ovule (see the embryo at the upper left hand side in Fig. 40).

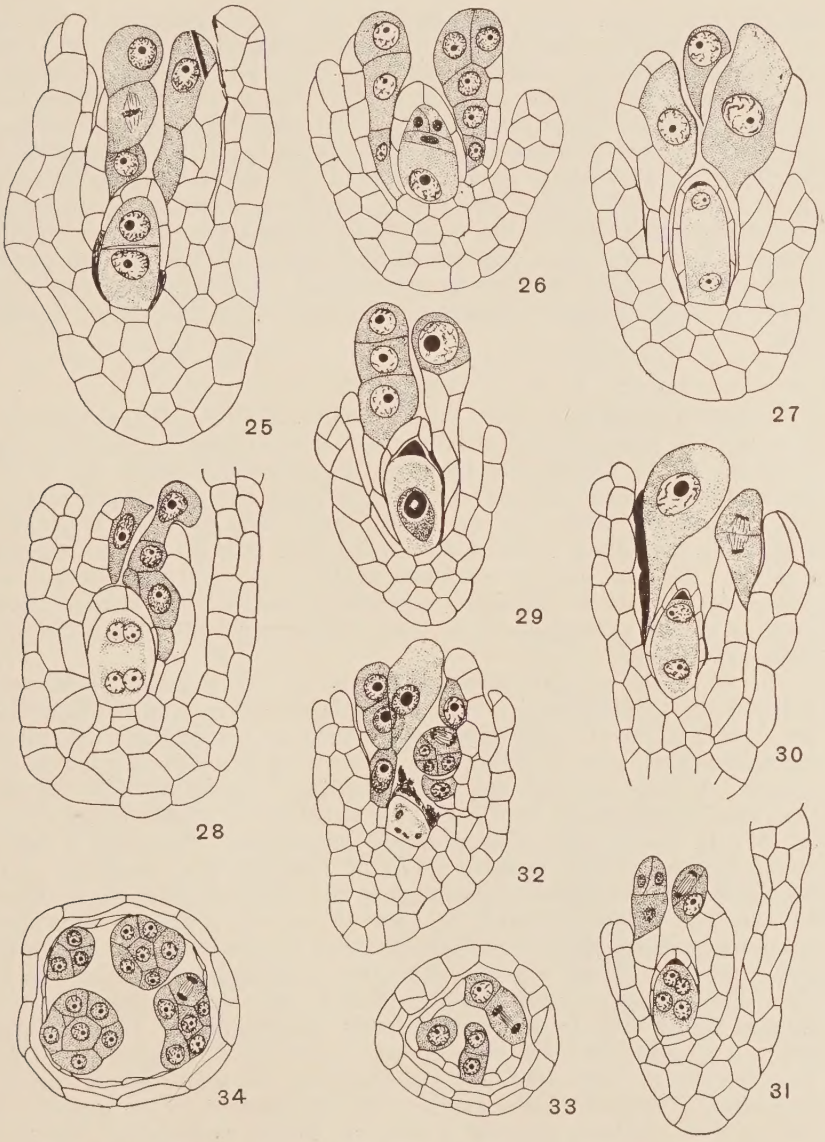
Aposporous embryo sacs.—Another unusual and rare phenomenon deserves mention. About 40 ovules exhibited this condition, four of which are shown in Figs. 35–38. The enormously enlarged terminal cell of the inner integument under these circumstances does not show any signs of division for a long time. While its nucleus continues to enlarge, the cytoplasm becomes highly vacuolated (Fig. 35). Then the nucleus undergoes mitosis, the two resulting nuclei move to opposite poles and a vacuole appears between them, giving the cell the appearance of a two-nucleate embryo sac (Fig. 36). The two nuclei in turn divide (Fig. 37) to produce an eight-nucleate coenocytic cell, which simulates a meiotically developed unorganized embryo sac (Fig. 38). Whether a nucleus of this structure develops into an embryo cannot be determined at this stage of the investigation. But a tendency for the development of aposporous embryo sacs is significant.

"INTERMEDIATE INDIVIDUALS"

Plants from a large number of collections studied exhibit clearly either one or the other of the methods of reproduction described above. However, two collections from Hancock County (Maine), Providence County (Rhode Island) and Hillsborough County (New Hampshire) and one from Kent County (Michigan) and Hartford County (Connecticut) show certain features that are suggestive of intermediate behavior. This is evidenced not only by a variety of irregularities in the development of the female gametophyte but also by the occurrence of adventive embryony, in addition to normal sexual method. However, polyembryony is less pronounced in these individuals than in the sexual race. It must be emphasized here that the degree of expression of these features is variable in different plants and future investigations based on a wider range of material may possibly show all gradations between perfectly sexual and typically apomictic individuals.

That the normal sexuality is disturbed in the plants under consideration may be witnessed by the following features: The development of the female gametophyte is attended by numerous abnormalities, essentially of the nature described for the asexual individuals. Although in spite of these adverse factors the embryo sac may attain an eight-nucleate stage, the mature organization of the gametophytic nuclei is always atypical. As a result of these interpolations, a varying proportion of the ovules—about 25% in the Hancock material to about 65% in the Kent material—in an ovary lacks fertilizable embryo sacs. On the other hand, microsporogenesis is not subjected to any adversities and normal pollen grains are produced in all individuals as in the sexual race. Moreover, the pollen grains even germinate on the stigma and fertilize normally developed ovules. The subsequent development of the zygote also follows the pattern described for the sexual race. No instances of adventive embryony were seen in these ovules.

The fate of the sterile ovules is interesting. Although pollen tubes generally avoid them, in a few instances a pollen tube penetrated the micropyle organized by the outer integument. However, before reach-



FIGS. 25–34. 25. Dyad stage. Note the densely staining group of cells of the inner integument in this as well as in the following figures. 26. T-shaped tetrad. 27. Two-nucleate embryo sac. 28. Four-nucleate embryo sac. 29. Enlargement of the chalazal dyad cell and degeneration of the micropylar one. 30. Chalazal dyad cell behaving as a two-nucleate embryo sac. 31. Chalazal dyad cell behaving as a four-nucleate embryo sac. 32. Longitudinal section of an ovule showing the degenerating four-nucleate embryo sac. 33. Transverse section of a young ovule at about the region of the micropyle, showing the initiation of adventive embryos. 34. Same, a later stage showing older embryos. All figures, × 360, excepting figures 32 and 34, which are magnified 180 times.

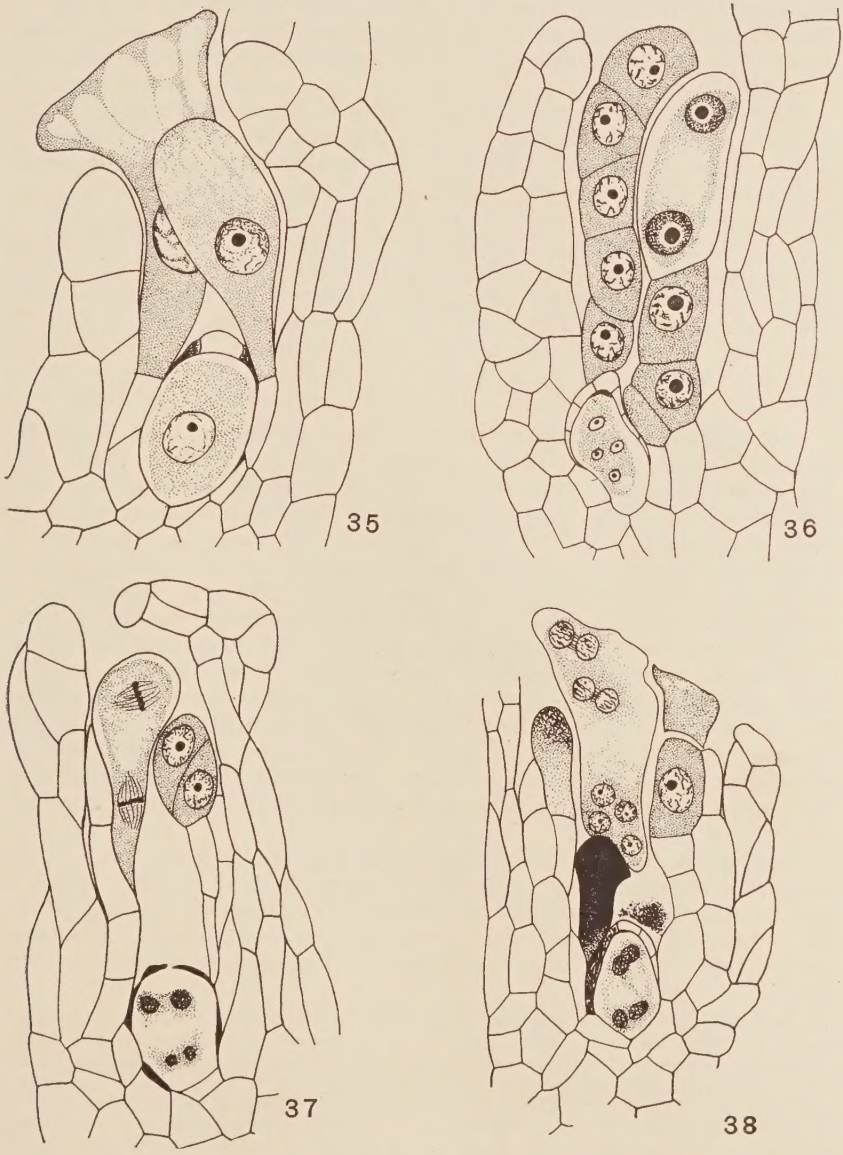
ing the micropylar canal organized by the inner integument, the tip of the tube had dried up and the contents degenerated. So far the cells of the integuments remained without any extraordinary features. But following fertilization in the normal ovules, some cells of the innermost layer of the inner integument in the sterile ovules soon become meristematic and produce adventive embryos as in the asexual race. Nevertheless, two points should be noted: (1) the number of embryos per seed does not exceed three, whereas in the asexual race it generally varies from two to six; (2) the origin of the adventive embryos is greatly delayed, i.e., until after the normally developed ovules in the ovary have been fertilized, whereas in the asexual race, they originate very early, namely, during or even before meiosis in the megaspore mother cell.

DISCUSSION

Female gametophyte.—The salient points of Pace's (1914) observations may be briefly stated as follows: (1) The embryo sac may develop from one of the megaspores (monosporic method) or from one of the dyad cells (bisporic method) or directly from the megaspore mother cell (tetrasporic method). (2) Both dyad cells or more than one megaspore may show signs of developing into embryo sacs to varying degrees. (3) The primary chalazal nucleus may fail to undergo the necessary number of divisions required to produce the normal components of the gametophyte, so that the mature embryo sac has less then eight nuclei.

In all species of *Spiranthes* studied so far—*S. australis* (Baranow, 1916), *S.* sp. (Maheshwari, 1946), *S. longilabris* (Swamy, unpublished)—the development of the embryo sac follows as a rule the monosporic eight-nucleate method. The same is true of the sexual race of *C. cernua*. In the asexual and "intermediate" races of this species, bisoporic development is occasionally seen as an abnormality (Figs. 30, 31), in addition to other atypical phenomena. Although a tetrasporic method was not seen by me in my material, the possibility of its occurrence in a negligible percentage of the ovules of these races is not entirely out of consideration in view of the wide range of atypical phenomena that disturb the normal sexual development of the female gametophyte. Pace's second observation, that both dyad cells or more then one megaspore may develop further, was substantiated in this present study only in the asexual and "intermediate" races. However, in no case did these cells undergo complete development. Thus this feature is just another manifestation of disturbed sexuality. Regarding Pace's third observation, the curtailment of the activity of the primary chalazal nucleus, it may be plainly stated that this is a general tendency met independently within several tribes of the orchid family (Swamy, 1948, 1948 a). These comments on Pace's findings lead us to conclude that her material did not represent a perfect sexual race, but rather an "intermediate" type.

Nature of reproduction.—As already mentioned in the introductory paragraph, opinions differ regarding the apomictic nature of *S. cernua*. It is evident from the observations recorded in the earlier part of this contribution, that the entire population is not homogeneous with



FIGS. 35–38. Figures illustrating some stages in the development of aposporous embryo sac. 35. Longitudinal section of an ovule showing the flaring out terminal cells of the inner integument; note the megaspore mother cell. 36. A terminal cell of the inner integument is in the two-nucleate stage; the regular four-nucleate gametophyte may be seen in its proper place. 37. The terminal cell of the inner integument on the one side has developed into a two-celled adventive embryo; that on the other side shows its two nuclei in the process of division. The nuclei of the sexually developed tetranucleate embryo sac are in a state of degeneration. 38. A terminal cell of the inner integument showing strong resemblance to a sexually produced eight-nucleate embryo sac; the regular four-nucleate sac has begun to degenerate. All figures, × 420.

reference to its sexual behavior. Individuals are known that show a perfectly normal amphimictic life cycle; others that exhibit predominant suppression of the sexual cycle and increased asexual reproduction; and "intermediate" types.

The behavior of the asexual individuals is rather significant: Mature pollen is rendered sterile through early degeneration of the cell contents; the development of the embryo sac is attended by a variety of abnormalities and the gametophyte fails to undergo a normal and complete development; pollination does not take place; the cells of the innermost layer of the inner integument develop into embryos and this is coupled with a high degree of polyembryony; there is a tendency for the formation of aposporous embryo sacs from the cells of the inner integument. These features afford ample evidence to consider the asexual race as exhibiting all essential characteristics of apomixis. As the embryos arise from the cells of the seed (inner integument), the phenomenon is more appropriately designated as agamospermy (Täckholm, 1922).

Mechanism of agamospermy in orchids.—Among orchids, *Nigritella nigra* (Afzelius, 1928, 1932), *Zeuxine sulcata* (Swamy, 1946) and *Spiranthes cernua* (present study) exhibit a strong tendency towards the loss of sexuality, the propagation of the species taking place by apomictic methods.* The loss of sexuality in these species varies in degree and the female sexual generation seems to be more affected than the male. The pollen development in *Nigritella* and *Spiranthes* is normal but pollen tubes have never been observed in the ovaries. In *Spiranthes*, the mature pollen begins immediate degeneration *in situ*. In *Zeuxine*, irregularities occur during the meiotic divisions so that only abnormal grains develop. In contrast to the male gametophyte, the female gametophyte never develops to maturity in any of the three genera. The embryo sacs of *Nigritella* and *Spiranthes* develop only as far as the four-nucleate stage. In *Zeuxine*, the degeneration of the female sexual cycle usually commences with the advent of the first reduction division itself.

Pollination has not been observed in any of the three species. In *Nigritella*, apomixis is not dependent on pollination but the latter is said to increase the apomictic tendency. In *Spiranthes*, Leavitt (1900, 1901) has already noted that seeds develop even when pollen was deliberately removed from the flowers before anthesis. My own

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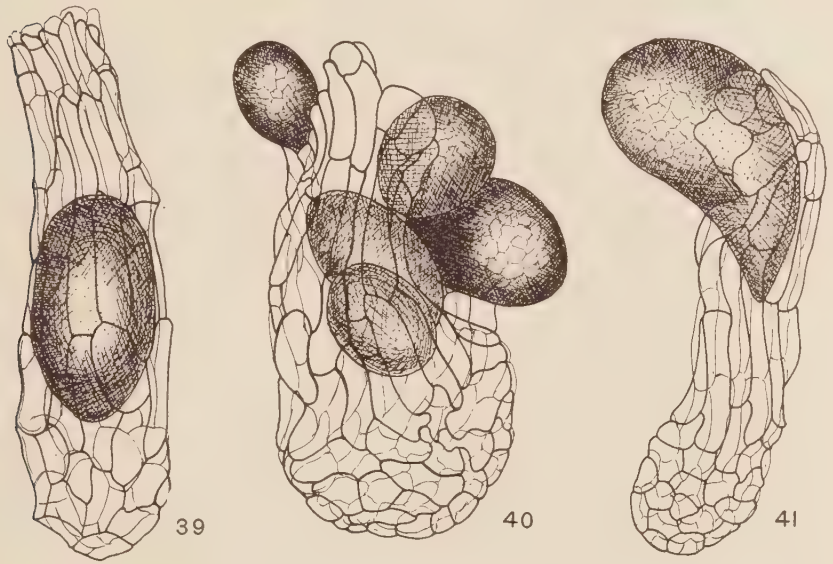
**Zygopetalum Mackayi* (Suessenguth, 1923), which is often cited as an apomict (Schnarf, 1929; Stebbins, 1941) deserves a thorough reinvestigation before its apomictic nature is established. From what has been written about this plant, it is not certain whether apomixis occurs habitually or sporadically. The latter condition seems to be more likely for these reasons: (1) the gametophytes develop normally; (2) pollination is essential for fruit and seed development; (3) although polyembryony is said to be due to the development of embryos from the chalazal and integumental regions, as well as from the cells of the egg apparatus, the exact mode of their origin remains to be clarified. However, the only basis on which these plants may be regarded as apomicts seems to be that, even when the flowers are pollinated with foreign pollen, seeds develop in spite of the fact that the pollen tubes fail to reach the embryo sacs. Gustafsson (1946) writes, ". . . there should be some remotely working chemical influence. The possibility is not excluded that pollination, instead of affecting the embryo development as such, influences the fruit development, as in experimental parthenocarpy, and thereby indirectly the full development of embryos."

observations on *Zeuxine* point to the conclusion that artificial pollination has no accelerating effect on the already prevalent apomictic phenomenon.

The actual method of origin of the agamospermic embryos in the three orchids is also varied. In *Nigritella* and *Zeuxine*, all embryos originate from the nucellar epidermis. In *Spiranthes*, they develop from the cells of the innermost layer of the inner integument. In all three species the cells with agamospermic potentiality are found close to the female gametophyte.

Frequency and distribution of the races.—Unfortunately no reliable characters in the gross morphology of the *S. cernua* population are known which would help to segregate the sexual and agamospermic races. The only method of distinhguising them is by a microscopic examination of the mature seeds.



FIGS. 39–41. 39. A typical seed produced by a sexual individual. 40. A polyembryonate seed produced by an agamospermic individual. 41. A monoembryonate seed produced by an agamospermic individual. All figures, × 260.

Comparative studies of a large amount of properly fixed material in all stages of development from different localities have now made it possible to characterize the three types of sexual polymorphics of *S. cernua* as follows:

Sexual race: The development of the male and female gametophytes is normal and complete. A single embryo is produced in every seed as a result of sexual fusion. The mature embryo occupies a more or less central position in the seed cavity. The contour of the seed coat is symmetrical and without any distortions (Fig. 39).

Agamospermic race: The mature pollen is rendered functionless through degeneration. The female gametophyte does not develop

to maturity and the course of development is attended by numerous atypical phenomena. Thus both gametophytes are sterile. The cells of the innermost layer of the inner integument give rise to two to six embryos per seed. The location of the embryos in the seed is very variable and quite often some of them lie outside the seed coat. The contour of the seed becomes variously distorted (Fig. 40). The occurrence of a single embryo per seed is exceptional. In such cases, the embryo invariably occupies an eccentric position and the contour of the seed coat is distorted (Fig. 41). These features provide clues to distinguish them from the monoembryonate seeds of the sexual race.

"*Intermediate*" *types:* A varying percentage of the ovules in an ovary behave as in the sexual race, while others follow the pattern of the agamospermic race.

Of these features, the characters of the seed, together with the presence or absence of polyembryony, may be taken as reliable criteria in analyzing mature seeds from herbarium material, and by this procedure it is possible to determine the method of reproduction of the plant in question. Following this procedure, 5,000 herbarium plants collected from 156 counties belonging to 28 states of the eastern half of the United States have been examined. Although care has been taken to include as large a number of specimens as possible for each state, it must be admitted that still larger collections are desirable from Pennsylvania, Ohio and West Virginia. Nevertheless, the following tentative results of the survey are here recorded (see Fig. 42);

1. The agamospermic individuals constitute the great majority of the population (4,068 plants out of 5,000). The sexual and "intermediate" individuals form a conspicuously small fraction (520 and 412 plants respectively).

2. The agamospermic race is widely distributed. The sexual and "intermediate" races occur in association with the agamospermic individuals but are restricted in distribution.

3. The sexual race seems to be largely confined to the New England states and fades out on the borders of New York, Pennsylvania, Maryland and Virginia. The "intermediate" race shows a slightly extended range; it has been collected from several localities in New York, Pennsylvania, West Virginia and Virginia. One collection from Macomb County, Michigan, also shows the characters of an "intermediate."

Any theoretical considerations relating to the phytogeographical and related aspects may be fruitful only after intensive and extensive cytological studies of the genus *Spiranthes* have been made.

SUMMARY

On the basis of life histories, the individuals of the *Spiranthes cernua* population may be divided into three races—sexual, agamospermic and "intermediate." The sexual race exhibits normal and complete functioning of the gametophytes, and as a result of syngamy a single embryo is produced in every seed. In the agamospermic race, the female gametophyte exhibits numerous abnormalities and fails to attain a fertilizable condition. The mature pollen also becomes functionless, so that the sexual cycle is incomplete. The integumental cells give rise

to two to six embryos in every seed. In the "intermediate" forms, some of the ovules of an ovary follow the course outlined for the sexual race and others for the agamospermic race.

Analysis of a large number of mature seeds from herbarium specimens tentatively indicates that the agamospermic race is dominant (81.4%) and more widely distributed, while the sexual and "interme-

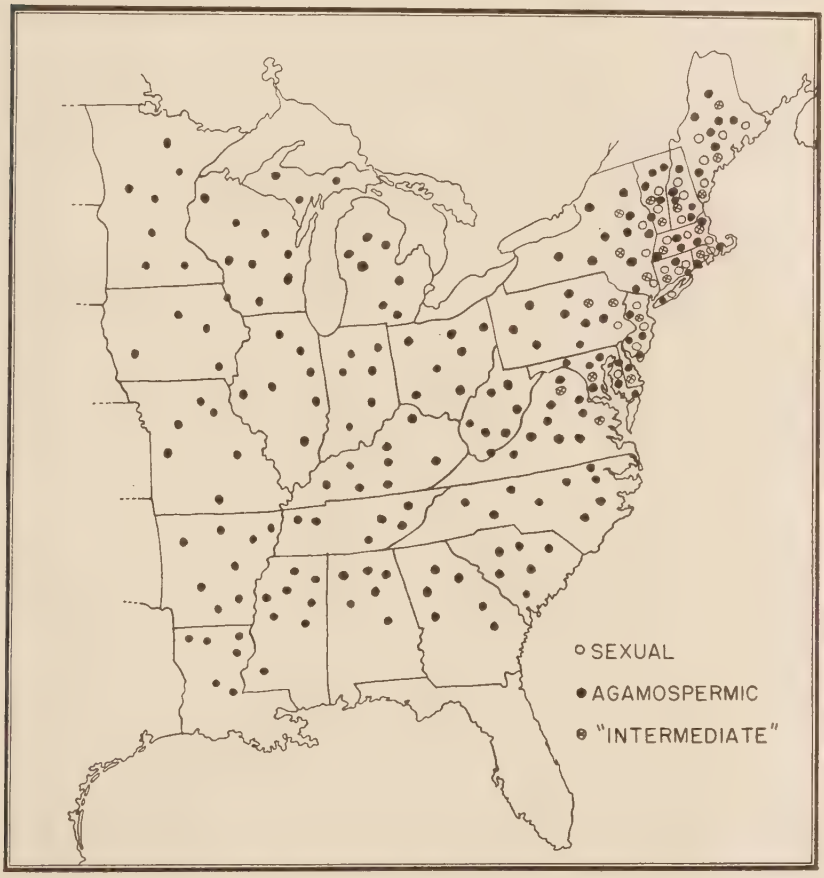


FIG. 42. Map showing the distribution of the sexual, agamospermic and "intermediate" races of *Spiranthes cernua*. Each symbol represents about 20 plants. However, it is not implied that all 20 plants belong to the same locality.

diate" races are represented in decidedly lower proportions (10.4% and 8.2% respectively) and restricted in distribution.

ACKNOWLEDGMENTS

At my request Professor Oakes Ames collected material from several localities for this investigation and permitted me to study the plants

in their natural habitat on his private grounds. Furthermore, he graciously placed alcohol-preserved material from the collections of the Botanical Museum at my disposal. I express my deepest gratitude to him for his kindly interest and unfailing encouragement. I am very thankful to Dr. Ledyard G. Stebbins for helpful suggestions. To Miss Charlotte S. Pratt I am deeply indebted for her assistance in the preparation of the manuscript.

LITERATURE CITED

Afzelius, K. 1928. Die Embryobildung bei *Nigritella nigra*. Sv. Bot. Tidskr. **22**: 82–91.

1932. Zur Kenntnis der Fortpflanzungsverhältnisse und Chromosomenzahlen bei *Nigritella nigra*. Sv. Bot. Tidskr. **26**: 365–369.

Baranow, P. 1916. Recherches sur le développement du sac embryonnaire chez les *Spiranthes australis* Lindl. et *Serapias pseudocordogera* Morie. Bull. Soc. imp. Nat. Moscou, N. S. **29**: 74-92.

Gustaffson, A. 1946. Apomixis in higher plants. Lunds Universitets Arsskr. N. F. **2**: 1–66.

Leavitt, R. G. 1900. Polyembryology in *Spiranthes cernua*. Rhodora **2**: 227–228.

1901. Notes on the embryology of some New England Orchids. Rhodora **3**: 61–63; 202–205.

Maheshwari, P. 1946. The Adoxa type of embryo sac: A critical review. Lloydia **9**: 73–113.

Pace, L. 1914. Two species of Gyrostachys. Baylor Univ. Bull. **17**: 1–16.

Schnarf, K. 1929. Embryologie der Angiospermen. Berlin.

Stebbins, G. L. 1941. Apomixis in Angiosperms. Bot Rev. **7**: 507–542.

Suessenguth, K. 1923. Über die Pseudogamie bei *Zygopetalum Mackayi* Hook. Ber. d. bot. Ges. **41**: 16–23.

Swamy, B. G. L. 1946. The embryology of *Zeuxine sulcata* Lindl. New Phytol. **45**: 132–136.

1948. Embryological studies in the Orchidaceae. I. Gametophytes. Amer. Midland Nat. (in press).

1948 a. Embryological studies in the Orchidaceae. II. Embryogeny. Amer. Midland Nat. (in press).

Täckholm, G. 1922. Zytologische Studien über die Gattung *Rosa*. Acta Horti Bergiani **7**: 97–381.

Studies in the Genus Poria*
IV. Brown Type Material

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This paper is a continuation of a previous article (Lowe, 1947) on studies of type material. The brown species of American porias proposed by Peck and Schweinitz have been adequately treated (Overholts, 1919, 1923). Some of Murrill's brown species have been redescribed or placed in synonymy (Baxter, 1937, 1941; Overholts, 1931, 1942). Many, however, have never been restudied, and information is here given on those species inadequately known, and a new disposition is proposed for a few when the author is not in agreement with currently published concepts.

These notes are based on a study of type materials deposited in the Herbarium of the New York Botanical Garden at New York, N. Y. (designated as "NY") and in large part duplicated at the Farlow Herbarium (designated as "F"), and, for one species, material in the Mycological Collections of the United States Department of Agriculture at Beltsville, Maryland (designated "USDA").

The type materials of 34 species were studied for this paper, 14 of which are placed into synonymy, apparently for the first time.

The writer is greatly indebted to Dr. F. J. Seaver and Dr. D. P. Rogers of the New York Botanical Garden; to Mr. J. A. Stevenson, Beltsville, Maryland, and to the late Dr. D. H. Linder of the Farlow Cryptogamic Herbarium, for the privilege of studying material under their care. Also Dr. W. A. Murrill, of Gainesville, Florida, kindly made available type material of *Poria punctatiformis*.

Poria castletonensis (Murr.) Sacc. and Trott., Syll. Fung. **21**: 336. 1912.

Figs. 1, 11

Fuscoporella castletonensis Murr., Mycologia **2**: 184. 1910.

Subiculum hyphae 2–3 μ in diam., frequently septate, mixed with setal hyphae; setae 20–33×5–8 μ, projecting up to 20 μ beyond the hymenium; basidia 8–9×4–5 μ; spores hyaline or nearly so, 3–4×2–2.5 μ.

The species is similar to *Poria demetrionis* but differs in being much paler, and in having much longer setae. *Poria ferruginosa* (Schrad. ex Fries) Cooke and resupinate *Polyporus gilvus* Fries also resemble this but are easily separated by the distinctly larger spores.

Specimen examined: Jamaica, Murrill 58, type (NY; F).

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*Contribution from the Department of Forest Botany and Pathology, The New York State College of Forestry, Syracuse, N. Y., and from the Farlow Reference Library and Herbarium of Cryptogamic Botany at Harvard University, Cambridge, Mass.

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PORIA CYLINDRISPORA Lloyd, Letter 65: 9. 1917.

This appears to be merely a thick perennial form of *Poria ferrea* (Pers.) Boud. and Galz.

Specimen examined: Montana, Weir 711, type (USDA, Lloyd Herbarium no. 49067).

PORIA CUBENSIS (Murr.) Sacc. and Trott., Syll. Fung. **21:** 334. 1912.

Figs. 2, 11

Fomitiporia cubensis Murr., North Amer. Flora **9,** 1: 8. 1907.

Basidia 11–13×6.8 μ; spores oblong-ellipsoid to oval, 4.5–6×2.5–4 μ.

This species seems closely allied to *Poria nigra* (Berk.) Cooke, from which it differs in having larger pores, 4–5 per mm., as opposed to pores usually 7–8 per mm. in *Poria nigra.*

Specimen examined: Cuba, Earle and Murrill 627, type (NY; F).

PORIA DEMETRIONIS (Murr.) Sacc. and Trott., Syll. Fung. **21:** 330. 1912.

Figs. 3, 11

Fomitiporella demetrionis Murr., North Amer. Flora **9,** 1: 12. 1907.

Pores 8–10 per mm.; subiculum hyphae infrequently septate, 2–4 μ in diam.; basidia 6–8×4.5–5 μ; setae projecting up to 15 μ; spores (not seen attached to basidia) hyaline, smooth, oblong-ellipsoid, 3–4×2.5 μ.

The distinctive characteristics of this species are the extremely minute pores, and the setal and spore characters. It may be confused with resupinate *Polyporus gilvus* Fries which has larger spores (4–6 ×3–4 μ), and larger subiculum hyphae (3–7 μ), or with *Poria punctatiformis* which has, however, larger pores and larger spores.

Specimen examined: Missouri, Demetrio 19, type (NY; F).

PORIA FLAVOMARGINATA (Murr.) Sacc. and Trott., Syll. Fung. **21:** 333. 1912.

Figs. 4, 11

Fomitiporia flavomarginata Murr., North Amer. Flora **9,** 1: 11. 1907.

Pores averaging 10 per mm.; setae ventricose, 16–24×5–7 μ, projecting up to 13 μ; basidia about 8×4–5 μ; spores (not seen attached) subglobose, hyaline or in age becoming faintly brownish, 2.5–3×2–2.5 μ. Associated with a white rot.

The extremely minute pores and spores characterize this species. *Poria demetrionis* has similar minute pores but in contrast has strictly hyaline spores and narrower setae; and *P. laevigata* resembles it, but has larger pores and spores.

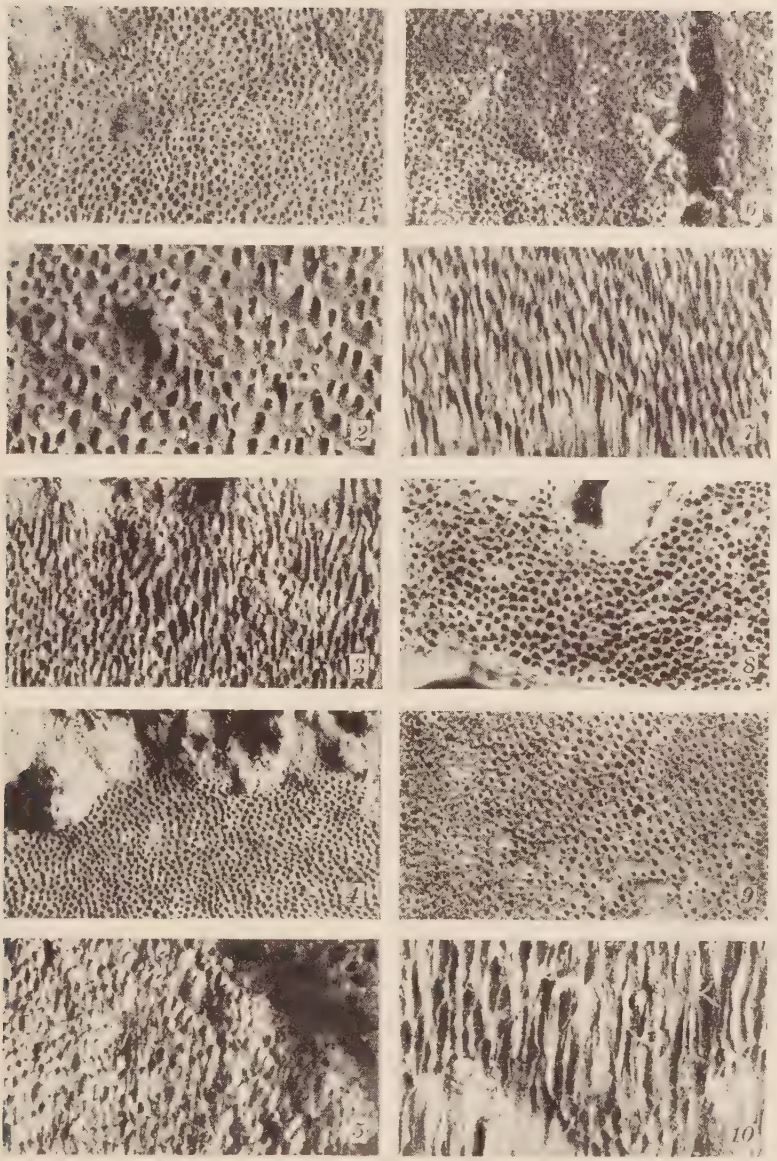
Specimen examined: Cuba, Earle and Murrill 559, type (NY; F).

PORIA FLORIDANA (Murr.) Sacc. and Trott., Syll. Fung. **21:** 329. 1912.

Figs. 5, 11

Fomitiporella floridana Murr., North Amer. Flora **9,** 1: 14. 1907.

Pores averaging 7 per mm.; subiculum hyphae 2–3 μ in diameter, very rarely septate; basidia 8–11×4.5–5 μ; spores broadly ellipsoid to oval, 3.5–4.5×2.5–4 μ. Associated with a white rot.



FIGS. 1–10. Pore surface of type specimens of *Poria*, all × 10. 1. *P. castletonensis*. 2. *P. cubensis*. 3. *P. demetrionis*. 4. *P. flavomarginata*. 5. *P. floridana*. 6. *P. johnsoniana*. 7. *P. ludoviciana*. 8. *P. melleopora*. 9. *P. punctatiformis*. 10. *P. undulata*.

This species is easily distinguished from *Poria inermis* E. and E., which has larger spores, 5–6×4–5 μ. The type collections of *Fomitiporella langloisiana* Murr. (North Amer. Flora **9,** 1: 13. 1907), of *Fuscoporella coruscans* Murr. (*ibid.*, p. 7), and *F. mexicana* Murr. (*ibid.*, p. 7) appear referable here, as the microscopic characters of all these agree, and the external differences do not appear to warrant specific separation.

It should be noted that *Poria coruscans*, the type species of the genus *Fuscoporella*, does not agree with the generic description, as it is not annual but perennial, having revived at least once.

Specimens studied: Florida, Calkins 850, type of *P. floridana* (NY; F); Louisiana, Langlois 2430, type of *P. langloisiana* (NY; F); Cuba, Earle and Murrill 473, type of *P. coruscans* (NY; F); and Mexico, Smith, type of *P. mexicana* (NY).

PORIA JOHNSONIANA (Murr.) Sacc. and Trott., Syll. Fung. **21:** 329. 1912.

Figs. 6, 11

Fomitiporella johnsoniana Murr., North Amer. Flora **9,** 1: 13. 1907.

Subiculum hyphae septate, 2.5–4(–5) μ in diameter; setae infrequent, subulate to somewhat ventricose, 19–22×6–9 μ, projecting up to 16 μ beyond the hymenium; spores ellipsoid to broadly oval, 3.5–4×2–3 μ.

This species, previously known only from the type, has a much wider distribution. It is the species redescribed under the name of *Fomes densus* Lloyd by Overholts (1931), and assigned a wide distribution in the Mississippi Valley. The most authentic available specimens of *F. densus*, however, are exactly as Lloyd described, that is, thick heavy forms of *Fomes conchatus* (Fries) Cooke.

Poria melleopora is externally very similar, but internally it differs in lacking setae and in having larger spores.

Specimens examined: Michigan, Johnson 1764, type (NY; F); Iowa City, Iowa, G. W. Martin (University of Iowa Herb. SUI 1677); Petawawa Forest, Ontario, Canada, A. H. Smith 26566 (Herb. University of Michigan); Ohio, Overholts Herb. Nos. 186, 254, 4216; Missouri, Overholts Nos. 635 and 965; Louisiana, Overholts No. 14736 (USDA Forest Path. No. 55488); and District of Columbia, Weir, Oct. 3, 1911. This last was widely distributed by Weir under the name "*Poria pereffusa*."

PORIA LAEVIGATA (Fries) Cooke

Fomitiporella betulina Murr. is a well-established synonym of *P. laevigata*. *Fomitiporia prunicola* Murr., although very similar, has been maintained as a valid species, on the basis of such uncertain characters as the relative scarcity of the setae and a substratum restriction to species of *Prunus*. In practice, specimens on *Prunus* have been called *P. prunicola*. On a morphological basis *P. prunicola* scarcely differs from and probably should be united with *P. laevigata*, although Baxter (1934) states that it is distinct in culture.

Fomitiporia pereffusa Murr., North Amer. Flora **9,** 1:10, 1907, has been considered a valid species (Baxter, 1933 and 1938; Lowe, 1946;

Overholts, 1942), but a restudy of the sterile type specimen indicates that the species has the same morphological characters and is a probable synonym of *P. laevigata.*

Fuscoporella ludoviciana Murr., North Amer. Flora **9,** 1: 6. 1907, (Fig. 7). differs so little from *P. laevigata* that it seems scarcely possible to maintain it as a separate species. Its color is somewhat paler, and the setae rarely assume the ventricose appearance of those of *P. laevigata,* but instead exhibit a more uniformly tapering shape as illustrated in Fig. 11. Transitional setal shapes can be found however, and no other taxonomic character is known that will validate the species.

Specimens examined: Maine, Murrill 2511, type of *Fomitiporella betulina* (NY; F); Louisiana, Langlois 1737, type of *Fuscoporella ludoviciana* (NY; F); Pennsylvania, Murrill 1130, type of *Fomitiporia perefusa* (NY; F); and Maine, Murrill 1922, type of *Fomitiporia prunicola* (NY; F).

PORIA MELLEOPORA (Murr.) Sacc. and Trott., Syll. Fung. **21:** 330. 1912.

Figs. 8, 11

Fomitiporella melleopora Murr., North Amer. Flora **9,** 1: 13. 1907.

Subiculum hyphae 3–4 μ in diameter, occasionally septate; basidia about 8×5 μ; spores broadly ellipsoid, $4.5–5.5\times3–3.5$ μ.

This species is very similar to *Poria floridana,* from which it differs in having larger subiculum hyphae, and pale brown, not dark brown, spores. Externally it is exactly like *P. johnsoniana* but internally it differs in lacking setae, and the spores are distinctly larger.

Specimen examined: Louisiana, Langlois 213, type (NY; F).

PORIA OHIENSIS (Murr.) Sacc. and Trott., Syll. Fung. **21:** 333. 1912.

Fomitiporia ohiensis Murr., North Amer. Flora **9,** 1: 11. 1907.

The type collection is sterile, but otherwise it, and several other collections from Ohio, agree exactly with *Poria megalopora* (Pers.) Cooke as exemplified by European specimens identified by Bresadola and Bourdot (in Herb. USDA).

It should be noted that the subiculum is pale in color and does not blacken in KOH solution. The species therefore is probably not a true brown Poria.

Specimen examined: Ohio, Lloyd 3130, type (NY; F), and Morgan 668 (NY), 201 and 189 (USDA).

PORIA PUNCTATA (Fries) Karst.

This common and widespread species has an extensive synonymy which includes, in accordance with the opinion of others (Overholts, 1942; and Baxter, 1936) *Poria laminata* (Murr.) Sacc. and Trott. and *P. obliquiformis* (Murr.) Sacc. and Trott. To this are added the following synonyms, based on studies of the type specimens of each: *Fomitiporia dryophila* Murr., North Amer. Flora **9,** 1: 8. 1907 (NY); *F. earleae* Murr., *ibid.,* p. 9, (NY; F); *F. jamaicensis* Murr., *ibid.,* p. 11, (NY); *F. langloisii* Murr., *ibid.,* p. 9, (NY; F); *F. lloydii* Murr., *ibid.,* p. 10 (but specimen sterile) (NY; F) and *F. maxoni* Murr., *ibid.* p. 11, (NY; F).

All the above were found on hardwood substrata. The following, on coniferous substrata, do not differ morphologically, and should be reduced to synonymy: *Fuscoporia juniperina* Murr., *ibid.*, p. 4, (NY; F); and *Fomitiporia tsugina* Murr., *ibid.*, p. 9, (NY; F).

The morphological characteristics of all these are the same as those possessed by *Fomes robustus* Karst. or, on conifers, by the synonymous *Fomes hartigii* (Allesch.) Sacc. and Trev. It is considered by the writer that all the species of *Poria* listed above are resupinate specimens of *Fomes robustus*. It is desirable, however, to have a name for the common resupinate condition, and the name *Poria punctata* seems best, employed in the sense of a form name.

It should be pointed out that this disposition is at considerable variance with the concepts of others. The validity of *P. tsugina* has been long accepted (Baxter, 1934; Lowe, 1946; Overholts, 1942), and

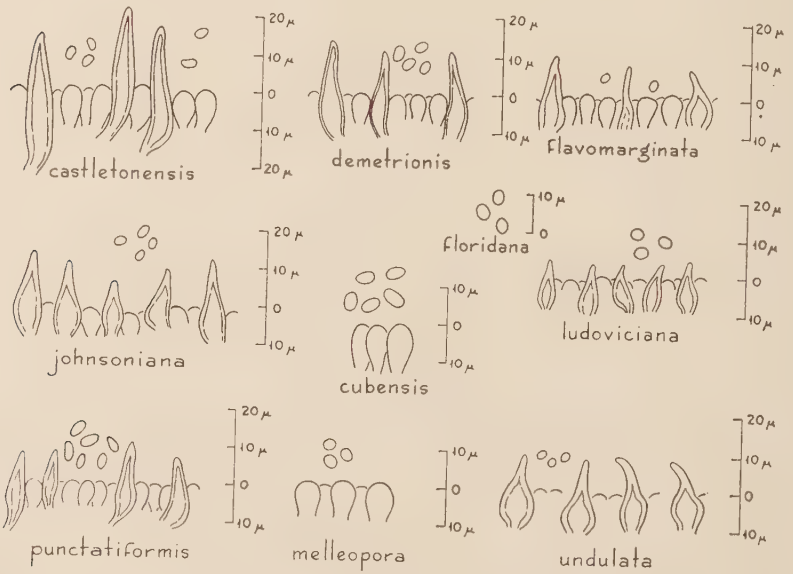


FIG. 11. Hymenial structures of species of *Poria* as drawn from the type specimens. The magnification is indicated for each drawing.

Baxter (1937) has also treated *Fomitiporia dryophila* and *F. earleae* as valid species, as well as *Fuscoporia juniperina* (Baxter, 1941). The synonymy of *Poria tsugina*, *F. dryophila*, and *Fomes robustus* has been indicated by Baxter (1934, 1945).

PORIA PUNCTATIFORMIS Murr., Bull. Torrey Bot. Club **65:** 661. 1938.
Figs. 9, 11

Fomitiporia punctatiformis Murr., *ibid.*, p. 659.

The most distinctive characteristics of this species are not stated in the original description. Mature spores are oblong to oblong-ellipsoid,

often slightly attenuate at one end, 4.5–6×1.5–2.5 μ, and setae are present, subulate, 16–19×4–5 μ. Subiculum hyphae 2–4 μ in diameter.

As the name implies, the species externally very closely resembles *P. punctata*. Internally the resemblance is much closer to *P. demetrionis*, from which it differs in having larger pores and usually more slender spores.

Specimens examined: Florida, Rhoads F 12073, type of *Fomitiporia punctatiformis;* G. Nelson, Sebastian, Florida, March, 1914 (F).

PORIA TENERRIMA (Berk. and Rav.) Cooke, Grevillea **14:** 115. 1886.

Polyporus tenerrimus Berk. and Rav. in Rav., Fung. Car. Fasc. 3, no. 13. 1855; and in Grevillea **1:** 65. 1872.

This species seems to have been based upon reticulate bark tissue, as all specimens examined lacked any trace of fungus mycelium.

Specimens examined: S. Carolina, Ravenel, Fungi Car., Fasc. 3, no. 13, type (NY; F; USDA), and Fungi Amer. Exs. 710 (NY; USDA); and Ellis, No. Amer. Fungi 922 (USDA).

PORIA UNDULATA (Murr.) Sacc. and Trott., Syll. Fung. **21:** 336. 1912.

Figs. 10, 11

Fomitiporia undulata Murr., North Amer. Flora **9,** 1: 10. 1907.

Pores 5–6 per mm.; setae rare, ventricose or varying to subulate, 16–19×5–8 μ, projecting up to 10 μ; spores oblong-ellipsoid to broadly ellipsoid, 3–4×2–3 μ.

This species is very similar internally to *Poria laevigata*, but differs externally in having distinctly larger pores.

Specimens examined: British Honduras, Peck, type (NY; F); not otherwise known.

SPECIES OF DOUBTFUL IDENTITY

Fomitiporella altocedronensis Murr., North Amer. Flora **9,** 1:12. 1907. Type collection sterile (NY; F).

Fomitiporia cinchonensis Murr., *ibid.*, p. 10. Type collection sterile (NY; F).

Fuscoporella costaricensis Murr., *ibid.*, p. 7. Type collection sterile (NY; F).

Fuscoporia nicaraguensis Murr., *ibid.*, p. 6. Spores uncertain, perhaps hyaline, ellipsoid, 3.5×2–2.5 μ. If the spore character as given above is correct, the fungus is most similar to *P. castletonensis*, from which it differs in having non-septate hyphae, and in lacking setal hyphae (NY; F).

Fuscoporella shaferi Murr., *ibid.* p. 7. The type collection is sterile. Setae occasional to fairly frequent, 13–16×4.5–5.5 μ (NY; F).

LITERATURE CITED

Baxter, Dow V. 1933. Some Resupinate Polypores from the Region of the Great Lakes. IV. Papers of the Michigan Academy of Science, Arts and Letters **17:** 421–439.
1934. V. *Loc. cit.* **19:** 305–332.
1936. VII. *Loc. cit.* **21:** 243–267.
1937. VIII. *Loc. cit.* **22:** 275–295.
1941. XII. *Loc. cit.* **26:** 107–121.
1945. XVI. *Loc. cit.* **30:** 175–191.
Bourdot, H., and **A. Galzin.** 1927. Hyménomycètes de France. Paris, France.
Lowe, J. L. 1946. The Polyporaceae of New York State (The Genus Poria). N. Y. S. College of Forestry Tech. Publ. **65.**
1947. Studies in the Genus Poria. II. White and Brightly-Colored Type Material. Lloydia **10:** 45–59.
Overholts, L. O. 1919. The Species of Poria Described by Peck. N. Y. S. Museum Bul. **205-206:** 67–166.
1923. The Species of Poria Described by Schweinitz. Mycologia **15:** 207–232.
1931. Diagnosis of American Porias. III. Some Additional Brown Species, with a Key to the Common Brown Species of the United States and Canada. Mycologia **23:** 117–129.
1942. The Polyporaceae of Pennsylvania. III. The Genus Poria. Pa. Agr. Exp. Sta. Tech. Bul. **418.**

Correlations Between Soil Properties and Pasture Productivity[1]

F. L. Wynd and G. P. Steinbauer[2]

INTRODUCTION

Experienced cattlemen have an almost uncanny ability to judge the quality of beef animals on pasture. Their purely subjective evaluation of the productivity of different pastures in terms of beef production often reaches a high degree of precision. Unfortunately, however, most cattlemen have no conception of the specific characteristics of soils which produce the desirable herbage and cannot, therefore, judge the quality of pasture soils until they have been grazed for several seasons.

The cattlemen of the United States are becoming more conscious of the importance of soil properties as a basis for planned pasture improvement, but such planning is seriously hindered because of the lack of precise data concerning the factors which limit productivity in specific areas. The present study is an effort to correlate certain specific properties of pasture soils in a limited area with the production of beef.

Table 1. *Description of the Soils.*

Soil No.	Location	Productivity Rating
1	Brooklawn, east.....	Poorest gains
2	Adams.....	Medium gains
3	Burnt House, east.....	Better than average gains
4	Maule, west.....	Best gains
5	Harney, Pasture 2.....	Improved pasture
6	Harney, Pasture 2.....	Improved pasture

EXPERIMENTAL MATERIALS AND METHODS

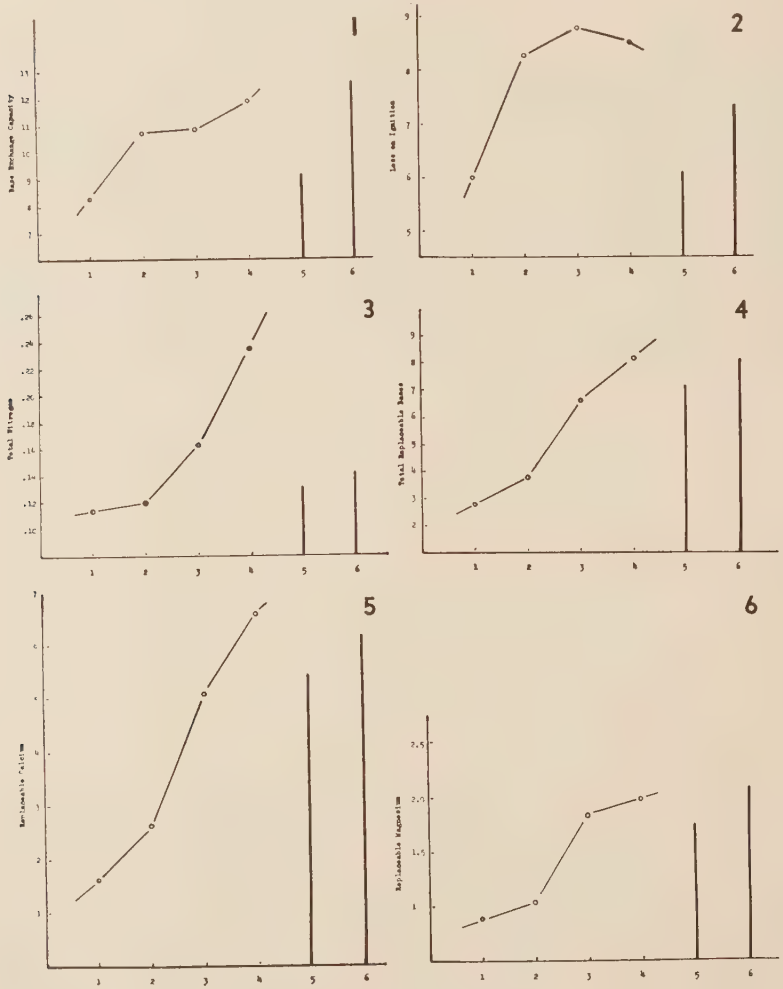
A group of 5 pasture soils in the vicinity of West Chester, Pennsylvania, were rated comparatively by experienced cattlemen of the area as to their productivity in terms of beef production. A detailed study of the soils was then carried out in an effort to detect correlations between soil properties and the pasture productivity.

Two highly improved pastures in the vicinity also were studied in order to compare the characteristics of pastures which had been artificially developed to a highly productive state by a program of liming and phosphate fertilization over a period of years with the characteristics of natural, unfertilized soils of similar productivity.

[1]The expenses of this study were borne by a grant-in-aid to the Department of Botany and Plant Pathology, Michigan State College, East Lansing, Michigan, by the King Ranch, Kingsville, Texas.

[2]Department of Botany and Plant Pathology, Michigan State College, East Lansing, Michigan.

The descriptions of the soils appear in Table 1. The soil numbers are in increasing order of productivity. Soils 5 and 6 refer to the highly improved pastures described above. The data are presented in Tables 2 to 4 inclusive, and in Figures 1 to 15 inclusive. The graphical units used in the figures are identical with those appearing in the tables.



FIGS. 1–6. Abscissa indicates soil number.

The following laboratory determinations were carried out on samples of the upper 8 inches of the soil profile: base exchange capacity,total replaceable bases, degree of base saturation, loss on ignition, total nitrogen, replaceable calcium, magnesium, and potassium, pH, lime requirement, and 4 different fractions of phosphorous. The soil samples were air-dried, pulverized, and sifted through a 16-mesh sieve. Nitrogen

was determined by the Kjeldahl procedure modified to include nitrates by the addition of salicylic acid and sodium thiosulphate to the digestion mixture.

The base exchange capacity was determined by leaching with neutral 1 N ammonium acetate, washing with neutral methyl alcohol, and then leaching with 1 N hydrochloric acid. The ammonia was distilled from the acid leachate into saturated boric acid, and titrated with standard acid. The total replaceable bases were determined in the ammonium acetate leachate which was ignited, and the resulting carbonates taken up in standard 0.1 N hydrochloric. The unused acid was then titrated with 0.1 N sodium hydroxide.

The titrated solution of total replaceable bases was used for the determination of the individual replaceable bases. The solution was acidified with 5 milliliters of 1 : 1 hydrochloric acid, and evaporated to

TABLE 2. *General properties of the soils.*

Soil No.	Base Exchange Capacity (m. e. per 100 gms.)			Total Replaceable Bases by Titration (m. e. per 100 gms.)			Loss on Ignition (per cent)			Total Nitrogen (per cent)		
	a	b	Ave.	a	b	Ave.	a	b	Ave.	a	b	Ave.
1	8.13	8.51	8.32	2.70	2.90	2.80	5.91	6.11	6.01	0.116	0.118	0.117
2	10.95	10.61	10.78	3.70	3.90	3.80	8.24	8.32	8.28	0.118	0.122	0.120
3	10.73	11.03	10.88	6.70	6.55	6.63	8.77	8.83	8.80	0.164	0.162	0.163
4	11.73	12.09	11.91	8.07	8.30	8.19	8.44	8.67	8.56	0.236	0.238	0.237
5	9.13	9.12	9.13	7.15	7.10	7.13	6.02	6.12	6.07	0.128	0.135	0.132
6	12.41	12.63	12.52	8.10	8.15	8.13	7.26	7.51	7.38	0.140	0.144	0.142

dryness. This process was then repeated and the residue taken up in 5 milliliters of 1 : 1 hydrochloric acid. 25 milliliters of water were added and then the solution was filtered. The filtrate was made alkaline with ammonia, and filtered to remove the sesquioxides. The filtrate was brought to volume and aliquots were used to determine replaceable calcium, magnesium and potassium.

The calcium was precipitated as the oxalate and titrated with standard hexanitrato-ammonium cerate, nitro-orthophenanthroline being used as an indicator. Magnesium was precipitated with 8-hydroxyquinoline, and the precipitate dried and weighed. Potassium was determined colorimetrically by the procedure of Peech (3).

The phosphorus fractions were determined by the procedure of Dickman and Bray (2). The fractions themselves were those described by Bray and Dickman (1). The fractions differed primarily in the intensity of the leaching process. Fraction 1 was extracted with neutral 0.1 N ammonium fluoride. Fraction 2 was extracted with 0.1 N ammonium fluoride in 0.01 N ammonium chloride after fraction 1 was removed. Fraction 3 was obtained by extracting with 1.0 n neutral ammonium fluoride, and subtracting the values obtained for

fraction 1 and 2. Fraction 4 was obtained by extracting at pH = 3.0 with 3.7 grams of solid ammonium fluoride, and subtracting the values obtained for fractions 1, 2 and 3.

EXPERIMENTAL RESULTS

Base exchange capacity.—The data presented in Table 2 and in Figure 1 show that the magnitudes of the base exchange capacity of the soils were positively related to their productivity. However, the improved soils, which were the most productive, differed greatly in the magnitude of their base exchange capacities. Soil 5 exhibited a base exchange capacity almost as low as the poorest pasture in the area, while soil 6 had a base exchange capacity equal to, or a little greater, than the best native pastures studied.

These apparently conflicting data suggest that, under natural conditions, the base exchange capacity is associated with soil factors more

TABLE 3. *Replaceable bases in the soils.*

Soil No.	Calcium (m. e. per 100 gms.)			Magnesium (m. e. per 100 gms.)			Potassium (m. e. per 100 gms.)		
	a	b	Ave.	a	b	Ave.	a	b	Ave.
1	1.61	1.68	1.65	0.87	0.71	0.79	0.77	0.87	0.82
2	2.64	2.62	2.63	0.98	1.16	1.07	0.32	0.38	0.36
3	5.00	5.21	5.10	1.76	1.87	1.82	0.34	0.48	0.41
4	6.51	6.59	6.55	2.22	1.79	2.00	0.55	0.69	0.62
5	5.42	5.50	5.46	1.55	1.96	1.75	0.40	0.42	0.41
6	6.22	6.22	6.22	2.23	2.20	2.22	0.36	0.36	0.36

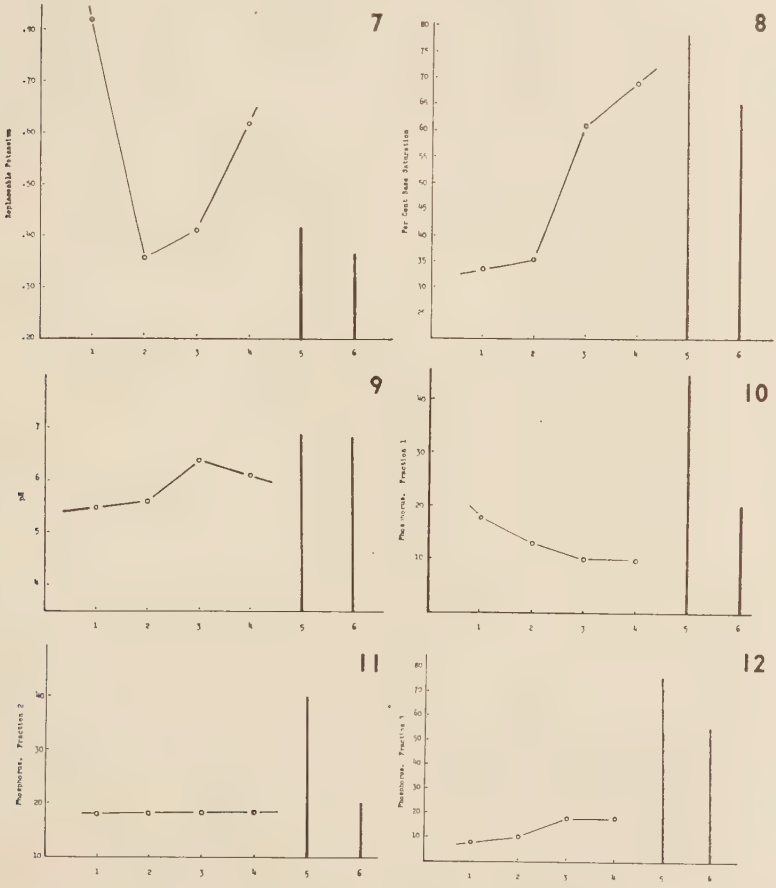
intrinsically important than the base exchange capacity itself, i.e., replaceable bases, nitrogen, etc. These other nutritional factors were increased artificially in the improved pastures without any necessary association with the base exchange capacity. This interpretation is further supported by the data discussed below.

Loss of ignition.—The amounts of organic matter in the soils, as indicated by the loss on ignition, show a similar relationship to pasture productivity as do the base exchange capacities. This similarity is to be expected, since such a large proportion of the base exchange capacity is due to the organic matter.

Total nitrogen.—The total amounts of nitrogen in the soils are presented in Table 2 and Figure 3. There is a very strong correlation between this characteristic of the natural soils and their productivity. On the other hand, the improved soils contain only about the same amount of nitrogen as the poorest soils in the vicinity. It is apparent, therefore, that nitrogen, *per se*, was not a limiting factor of pasture production. The inherent, more or less quantitative association of nitrogen with organic matter and base exchange capacity, again

predicates similar relationships between these soil characteristics and the observed productivity of the pastures. The low nitrogen content of the improved soils indicates that their superior quality was not dependent on this soil component.

Total replaceable bases.—The data presented in Table 2 and Figure 4 show that there was a very close relationship between the



FIGS. 7–12. Abscissa indicates soil number.

amount of total replaceable bases in the natural soils and the productivity of the pastures. The improved soils contained about the same amount of replaceable bases as did the best unfertilized soils. These data suggest that the improvement brought about by the careful management in soils 5 and 6 was probably due to the increase in the amount of total replaceable bases. The individual bases responsible for this increase will be discussed below.

Replaceable calcium.—A strongly positive relationship between the

amounts of replaceable calcium and the productivities of the soils is seen from the data in Table 3 and Figure 5. In fact, this is one of the most consistent relationships observed. It is especially interesting to note that the amounts of replaceable calcium in the improved pasture soils are of the same magnitude as those in the best native soils of the area, which indicates that the large amounts of calcium added to these soils over a period of several years was an important factor in their improvement.

Replaceable magnesium.—The data presented in Table 3 and Figure 6 indicate that amounts of replaceable magnesium in the natural soils closely parallel the productivity of the pastures. The amounts of this nutrient ion present in the improved soils were of the same

TABLE 4. *pH relationships of the soils.*

Soil No.	Base Saturation (per cent)			pH			Lime Requirement (Lbs. per acre)					
							By Titration			By Calculation		
	a	b	Ave.	a	b	Ave.	No. 4 mesh	Fine mesh	Pure $CaCO_3$	a	b	Ave.
1	33.2	34.0	33.6	5.5	5.5	5.5	8350	6222	5000	5430	5610	5520
2	35.6	34.8	35.2	5.6	5.6	5.6	8350	6222	5000	7050	6910	6980
3	62.5	59.4	61.0	6.4	6.4	6.4	6680	5000	4000	4030	4480	4260
4	68.8	69.3	69.0	6.1	6.1	6.1	6680	5000	4000	3660	3790	3725
5	78.3	77.9	78.1	6.9	6.9	6.9	3340	2250	2000	1980	2020	2000
6	65.3	64.5	64.9	6.8	6.8	6.8	6680	5000	4000	4310	4480	4400

magnitude as those in the best natural soils of the area. Just as in the instance of replaceable calcium, this situation suggests that much of the improvement brought about by past fertilizer treatments was due to the magnesium added in the limestone fertilizer. It is improbable that magnesium itself is as important as the effect which it had in contributing to a more favorable degree of base saturation and pH.

Replaceable potassium.—Data presented in Table 3 and Figure 7 show that there was no discernible trend in the relationship observed between the amounts of replaceable potassium in the pasture soils and their productivity. The small amounts of replaceable potassium in the highly productive improved soils indicate that this nutrient was not a limiting factor of the productivity of the pastures of the area studied.

Base saturation.—The degree of base saturation of the soil colloids appears to be an important factor in pasture productivity in the area studied. Not only do the natural soils show a very strong positive correlation between the degree of base saturation and productivity, but the same is true of the improved soils. The discussion above

concerning the individual replaceable bases makes it apparent that the large amounts of replaceable calcium and magnesium are chiefly responsible for the magnitude of the degree of base saturation.

pH.—The pH values of the soils presented in Table 4 and Figure 9 show that the pH values of the least productive pasture soils were about 5.5, while those of the better soils were greater than 6.0. The improved soils exhibited pH values of about 6.8. These data are clearly related to the degree of base saturation. The higher values for the improved soils reflect the effect of continuous liming and superphosphate applications.

Phosphorus, fraction 1.—The amounts of fraction 1 phosphorus in the natural soils were inversely proportional to productivity. Yet, the data in Table 5 and Figure 10 show comparatively high values for this phosphorus fraction in the improved soils. The past history

TABLE 5. *Phosphorus fractions in the soils.*

Soil No.	Fraction 1 (p. p. m.)			Fraction 2 (p. p. m.)			Fraction 3 (p. p. m.)			Fraction 4 (p. p. m.)		
	a	b	Ave.	a	b	Ave.	a	b	Ave.	a	b	Ave.
1	15	20	18	20	15	18	10	5	8	60	60	60
2	10	15	13	10	15	13	15	5	10	35	20	28
3	10	10	10	5	10	8	20	15	18	35	30	33
4	10	10	10	10	15	17	20	15	18	40	40	40
5	45	45	45	40	40	40	75	75	75	65	90	78
6	20	20	20	20	20	20	60	50	55	60	65	63

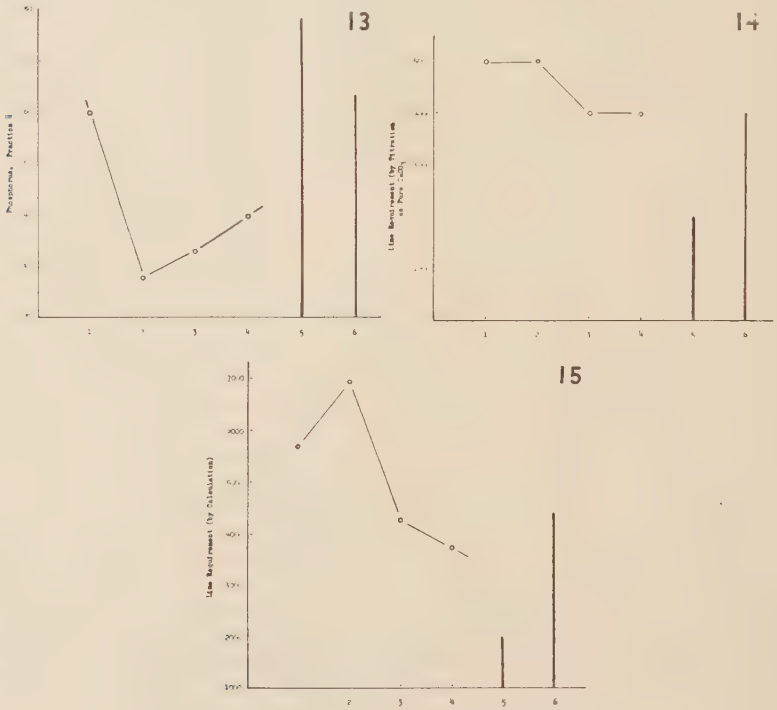
of phosphate fertilization is reflected by these data, but apparently this phosphorus fraction is not responsible for the high quality of the native unfertilized soils.

Phosphorus, fraction 2.—The data in Table 5 and Figure 11 show that this soil phosphorus fraction was the same in all the natural soils, irrespective of the productivity of the pastures. The improved pasture soil 5 showed a notable increase of this fraction although but little change was noted in soil 6.

Phosphorus, fraction 3.—Soil phosphorus fraction 3 was positively related to the productivity of the unfertilized pastures. This soil phosphorus fraction, sometimes denoted "chemosorbed" phosphorus, has been shown by Wynd and Noggle (5, 6) to be quantitatively related to the amount of organic matter present. The data obtained in the present study verify this association. Since organic matter, nitrogen and chemosorbed phosphorus vary quantitatively with each other, the specific importance of any one of these soil factors cannot be postulated separately. However, if Figures 2 and 3 be compared with Figure 12 it is apparent that the high productivity of the improved pastures is associated with the high values of chemosorbed phosphorus, but not with organic matter or with nitrogen. We may suppose therefore,

that the chemosorbed phosphorus was more influential in determining the pasture productivity than was organic matter of nitrogen.

Phosphorus, fraction 4.—This fraction of soil phosphorus was determined by a procedure which was essentially a quantitative "quick test." Data in Table 5 and Figure 13 show that this fraction was not necessarily related to the productivity of the unfertilized pastures. The improved pastures 5 and 6, however, exhibited very high values for this phosphorus fraction. Figure 13 shows that this quick test may have been a satisfactory indication of pasture productivity for soils



FIGS. 13–15. Abscissa indicates soil number.

2, 3, and 4, but it gave an erroneous indication for soil 1, the poorest soil of all.

Lime requirement.—The quantitative data discussed above suggest that the soils of the area studied were deficient in calcium. The lime requirement was, therefore, determined by titration of the supernatant liquid of standard soil suspension and also by calculation from the base exchange capacity and the degree of base saturation. The data are presented in Table 4 and in Figures 14 and 15. The lime requirements of the unfertilized soils decrease with increase of pasture productivity. The lime requirement of the improved pastures is about equal to, or less than, that of the best unfertilized fields. The low

lime requirement of soil 5 is dependent on the comparatively low base exchange capacity rather than on a difference in the pH value.

DISCUSSION

An examination of all the data presented indicates that the better natural soils and the soils improved by years of good management and by regular lime and phosphate applications exhibited high values for total replaceable bases, replaceable calcium and magnesium, degree of base saturation of the soil colloids, pH, and phosphorus. The lack of any evidence of an increase in nitrogen or organic matter in the highly productive improved soils, together with the data on base saturation, and phosphorus shows that the application of lime and phosphate applications are the most essential factors in the area studied for the improvement of permanent pastures.

The strong positive relationship between the amount of total replaceable bases, especially of replaceable calcium, dominates even the effect of nitrogen in determining the productivity of the pastures studied. This dominance of the effects of replaceable bases over that of nitrogen agrees with the results obtained near Midland, Kansas, by Wynd and Noggle for the growth of oats (7), or rye (8), and of Sudan grass (4). From the economic point of view, the application of nitrogen is expensive and short-lived, while the effects of a program of lime and phosphate application are long lasting and ultimately will permanently improve the productivity of pastures in the area studied.

The data concerning soil phosphorus verify the former reports of Wynd and Noggle (9) that the "chemosorbed" phosphorus is more closely related in its effect on plant growth than are any of the other fractions studied.

The comparison of the data for the highly improved pasture soils with those for unfertilized pastures in the vicinity shows that the program of lime and phosphate applications had increased the pH values from about 5.5 to about 6.8, increased the amount of total replaceable bases, especially of calcium and magnesium, and increased the amount of phosphorus. The improvement of the fertilized pastures was not due to changes in the nitrogen content, replaceable potassium, nor of organic matter.

SUMMARY

1. Six pastures with a long history of continuous cattle grazing, in the vicinity of West Chester, Pennsylvania, were rated by experienced cattlemen as to their beef productivity. Four of these soils had received no fertilizer, and two had received lime and phosphate at frequent intervals over a period of years. The herbage was essentially a Blue grass (*Poa pratensis*) and Ladino clover mixture.

2. Various properties of the soils were determined in an effort to detect the factors which influenced beef productivity in the unfertilized soils, and to serve as indications of an effective program of pasture improvement.

3. The data show that the highly productive improved soils, and the best unfertilized native pasture soils, exhibited a higher degree of base saturation, a higher pH value, increased replaceable bases,

especially of calcium and magnesium, and an increased phosphorus content.

4. The high quality of the improved pasture soils was not dependent on their content of nitrogen, replaceable potassium, nor organic matter.

5. The dominant effect of the amounts of total replaceable bases over that of nitrogen agrees with data obtained near Midland, Kansas.

6. Chemosorbed phosphorus was the fraction of soil phosphorus most nearly related to pasture productivity. "Quick" test for soil phosphorus occasionally gave erratic results.

7. A program of lime and phosphate application is an effective fertilizer program of pasture improvement in the area studied.

LITERATURE CITED

(1) **Bray, R. H.,** and **Dickman, S. R.** Tentative fluoride extraction methods for soil phosphorus. Mimeographed pamphlet. Ill. Agr. Exp. Sta. Ag. 1006. 1942.

(2) **Dickman, S. R.,** and **Bray, R. H.** Colorimetric determination of phosphate. Ind. Eng. Chem., Anal. Ed. **12:** 665–668. 1940.

(3) **Peech, M.** Determination of exchangeable bases in soils. Ind. Eng. Chem., Anal. Ed. **13:** 436–441. 1941.

(4) **Wynd, F. L.** Effects of selected properties of soils in growth of Sudan Grass. Lloydia **9:** 146–152. 1946.

(5) **Wynd, F. L.,** and **Noggle, G. R.** Associations between phosphorus fractions and other chemical components in soil. Soil Sc. **56:** 383–391. 1943.

(6) **Wynd, F. L.,** and **Noggle, G. R.** Influence of nutritional factors on the correlation between the vitamin C concentration and the growth of cereals. Food Res. **11:** 373–379. 1946.

(7) **Wynd, F. L.,** and **Noggle, G. R.** Relationships between certain chemical properties of soils near Midland, Douglas County, Kansas, to yield of oats harvested at the jointing stage. Food Res. **10:** 408–414. 1945.

(8) **Wynd, F. L.,** and **Noggle, G. R.** Relationships between chemical properties of soils near Midland, Douglas County, Kansas, to yield of rye harvested at the jointing stage. Food Res. **11:** 121–126. 1946.

9) **Wynd, F. L.,** and **Noggle, G. R.** Relationships between fractions of phosphorus in soil and growth of cereals. Food Res. **11:** 210–215. 1946.

Arundo donax as a Forage Grass in Sandy Soils[1]

F. L. Wynd,[2] George P. Steinbauer,[3] and N. R. Diaz[4]

INTRODUCTION

Arundo donax, commonly known as Giant Reed Grass, Georgia Cane, or Carrizo, was introduced into the United States from the warm regions of the old world. It may now be found in the southern part of the Country from California to Texas, and occasionally further eastward in the Gulf states. It commonly grows along irrigation ditches in these areas.

Frequently it is cultivated as an ornamental species because of its robust and beautiful growth habit. The variety *versicolor* is especially favored as an ornamental plant. In the Southwest, the culms are used for lattices, mats and screens, and in the construction of adobe huts. The culms are extensively used in Europe for making the reeds of such musical instruments as clarinets, saxophones and organ pipes.

Giant Reed Grass is rarely regarded as a suitable pasture species, even in the areas where it grows most luxuriantly, and certainly any species of grass which produces culms with a texture suitable for building purposes and for the reeds of musical instruments is not likely to be looked upon with favor by cattlemen. Actually, however, this species may serve as an important forage plant under certain conditions. The purpose of the present paper is to report the conditions of its use on the King Ranch, Texas, and to present chemical data illustrating its nutritional value for cattle.

Giant Reed Grass has been grown on the King Ranch in small colonies for ornamental purposes for many years. More recently, several rows were planted by accident on the Armstrong Ranch on a partly stabilized sand dune. This planting survived and produced a surprisingly vigorous growth, which was all the more surprising since this species grows best along the moist banks of irrigation canals. Ordinarily, the extensive sand dunes along the Texas coast are regarded as exceptionally dry habitats, and it is assumed that only xerophytic species will thrive on them. However, examination of these dunes, even in the hottest and driest weather, shows the presence of moist sand within a few inches of the surface. The remarkably low rate of evaporation from the dunes enabled this tropical, moisture loving grass to survive. Since this accidental discovery of the ability of Giant Reed Grass to thrive on sand dunes, it has been extensively used on the King Ranch to prevent wind erosion in sandy areas.

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[1]The expenses of the present investigation were borne by a grant-in-aid by the King Ranch, Texas, to the Department of Botany and Plant Pathology, Michigan State College, East Lansing, Michigan.

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Giant Reed Grass is not very palatable to cattle, but during the drier seasons when other species are dormant, the animals do not hesitate to graze this species. The younger shoots are eaten first, and then the upper parts of the older plants. It is apparent that Giant Reed Grass may assume an important place as a pasture species during the drier seasons of the year in the sandy areas of the Texas Coastal plain.

Since Giant Reed Grass is becoming increasingly recognized as a sandy binding species in some pasture areas, the value of the herbage as a forage for cattle was investigated, and the data are reported below.

EXPERIMENTAL METHODS

The material used for analysis was collected from a well established planting in Kennedy County, about five miles east of Armstrong on Highway 77, in April, 1947. The tissue of the upper and lower parts of young and old plants were collected separately. The material was dried and ground in a Wiley mill to pass a 40 mesh screen. Just before analysis, the powder was brought to constant weight in an oven at 90 degrees centigrade. The percentages of the components determined are reported on the oven-dry basis.

Total nitrogen was determined by the Official Association of Agricultural Chemists Kjeldahl procedure as modified to include nitrites and nitrates (1).

The material was prepared for the analysis of phosphorus, calcium, magnesium and potassium by digesting 1 gram of the dry powdered material in a mixture of 5 milliliters each of water, nitric acid and perchloric acid. The digested sample was evaporated to dryness, taken up in dilute nitric acid, filtered, and brought to volume. Aliquots of the filtrate were used for analysis.

Phosphorus was determined by the method of Dickman and Bray (2) in which the color produced by phosphorus in the presence of ammonium molybdate-hydrochloric acid solution and stannous chloride was measured in a Coleman spectrophotometer. Readings were converted into concentrations by comparison with a standard curve for known amounts of phosphorus.

Calcium was determined by precipitation as calcium oxalate. The latter was titrated with standard ammonium hexani trato-cerate in the presence of perchloric acid, using nitro-orthophenanthroline ferrous perchlorate as indicator.

Magnesium was determined gravimetrically by precipitation with 8-hydroxyquinoline and weighing the precipitate after two hours drying at 140° C.

Potassium was determined by a method essentially similar to that of Peech (3). The plant powder was wet ashed by the nitric-perchloric acid method, dried, dissolved in 10 ml. of 0.1 N nitric acid. Three ml. were used for the potassium determination. The actual determination was carried out by addition of 25% sodium cobaltinitrite reagent to the sample, cooling centrifuging and washing the precipitate with 70% ethyl alcohol, after which it was taken up in 2 N sulphuric acid. The intensity of color produced when a 0.5% solution of nitroso-R-salt was added in the presence of sodium pyrophosphate and sodium acetate

was read in a Coleman spectrophotometer. Concentrations of potassium were read from a previously prepared standard curve.

Acid hydrolyzable carbohydrate was determined by the procedure recommended for feeds and grains by the Official Association of Agricultural Chemists (1), except that 1 gram samples were refluxed for 2 hours in 200 milliliters of a solution containing 5 milliliters of concentrated hydrochloric acid.

TABLE 1. *Composition of Georgia Cane, indicated as percentages of the oven-dry weight.*

COMPONENT	OLD PLANT					
	LOWER HALF			UPPER HALF		
	Det. 1	Det. 2	Ave.	Det. 1	Det. 2	Ave.
Total nitrogen	0.62	0.64	0.63	1.07	1.12	1.10
Protein (total N×6.25)	3.88	4.05	3.94	6.69	7.00	6.88
Phosphorus	0.080	0.084	0.082	0.120	0.108	0.114
Calcium	0.59	0.52	0.56	0.66	0.68	0.67
Magnesium	0.27	0.22	0.25	0.32	0.32	0.32
Potassium	1.96	2.12	2.04	2.40	2.44	2.42
Carbohydrate	22.9	23.4	23.2	22.2	21.1	21.7

COMPONENT	YOUNG PLANT					
	LOWER HALF			UPPER HALF		
	Det. 1	Det. 2	Ave.	Det. 1	Det. 2	Ave.
Total nitrogen	0.52	0.47	0.50	1.98	1.93	1.96
Protein (total N×6.25)	3.25	2.94	3.13	12.38	12.06	12.25
Phosphorus	0.102	0.108	0.105	0.144	0.160	0.152
Calcium	0.33	0.26	0.30	0.46	0.40	0.43
Magnesium	0.12	0.11	0.12	0.19	0.19	0.19
Potassium	3.12	3.06	3.09	3.20	3.18	3.19
Carbohydrate	19.8	20.2	20.0	20.0	21.4	20.7

EXPERIMENTAL DATA

The analytical data are presented in Table 1. Crude protein is seen to attain a concentration of about 12 per cent in the upper half of the younger plants, and about half of this concentration in the upper half of the older plants. The lower parts of both the old and young plants, on the other hand, contained only 3 to 4 per cent protein.

The phosphorus content also was greater in the upper half of the plants. In the younger plants the concentration was about 0.15 and in the older plants about 0.10 per cent. In the lower half of the plants, the concentration of phosphorus was about 0.10 per cent in the younger and about 0.08 in the older plants. The comparatively high concentra-

tion in the upper half of both old and young plants is especially significant since the soils in the general area from which the samples were collected are known to be dangerously low in phosphorus for the production of pasture forage.

The calcium content of both the upper and lower parts of the plants was higher in the older plants. There was a considerably greater concentration of this element in the upper tissues than in the lower.

The percentage of magnesium was conspicuously greater in the older plants, and especially so in the upper half. Calcium and magnesium are alike in this respect.

The amount of potassium was greater in the younger plants, with a slightly greater concentration in the upper half. Although there was less potassium in all parts of the older plants, there was a little more in the upper half than in the lower.

The total acid hydrolyzable carbohydrate content was a little greater in the older plants than in the younger, especially in the lower half. There was very little difference in the carbohydrate content of the upper and lower parts of the younger plants.

SUMMARY

1. Giant Reed Grass (*Arundo donax*) was successfully established on partly stabilized sand dunes near Armstrong, Kennedy County, Texas. The upper and lower halves of young and old plants were analyzed for nitrogen, phosphorus, calcium, magnesium, potassium, and acid hydrolyzable carbohydrate.

2. Nitrogen, phosphorus and potassium exhibited the greatest concentration in the upper half of the younger plants.

3. Calcium and magnesium exhibited the greatest concentration in the upper parts of the older plants.

4. Total acid hydrolyzable carbohydrate was greater in the older plants, and especially so in the lower half.

5. The use of Giant Reed Grass as a sand-binder and as a pasture grass in the sandy areas of the Texas plain is discussed.

LITERATURE CITED

(1) **Association of Official Agricultural Chemists.** Official and tentative methods of analysis. Ed. 6. Washington, D. C. 1945.

(2) **Dickman, S. R.,** and **Bray, R. H.** Colorimetric determinations of phosphate. Ind. Eng. Chem., Anal. Ed. **12**: 665–668. 1940.

(3) **Peech, M.** Determination of exchangeable bases in soils. Ind. Eng. Chem., Anal. Ed. **13**: 436–441. 1941.

Studies in South American Plants, I

Jose Cuatrecasas
(*Chicago Natural History Museum, Chicago, Ill.*)

This series includes taxonomic studies on a number of species and genera of South American plants, based chiefly on my own collections from Colombia and on others represented in the Herbarium of Chicago Natural History Museum. My study of the genus *Weinmannia* was greatly aided by loans of many fine specimens from the United States National Herbarium and the New York Botanical Garden.

BOMBACACEAE

Matisia N. et B. and Quararibea Aubl.

The differences between these two genera are not constant enough to justify retaining both of them, as Baillon[1] and Vischer[2] demonstrated long ago. My study of the abundant material available to me convinced me to accept this viewpoint and, as a result, *Matisia* is here treated under *Quararibea*, the older name.

Quararibea leptandra Cuatr., sp. nov.

Arbor 15 metralis. Caulis 30 cm. diam. cortice griseo crasso, sectione ochraceo. Rami terminales brunneo-virides laeves, tomento minutis stellatis pilis adpresse obtecti. Stipulae deciduae ovato-triangulares, 6 mm. longae x 4–5 mm. latae, tomentosae.

Folia grandia subcoriacea integra petiolata pallido-viridia. Petiolus 1.5–2 cm. longus crassus pilis stellatis obtectus. Lamina obovato-elliptica plus minusve oblonga basi rotundata vel emarginata apicem versus attenuata, acuminata; margine integra; quintuplinervis tribus nervis centralibus magis elevatis, nervis secundariis tertio superiore arcuato-ascendentibus, reliquis transversis et laxo reticulo valde conspicuo; subtus minutis pilis stellatis vel fasciculatis munita basim versus copiosioribus; supra sparsioribus pilis; 20–33 cm. long. x 8–13.5 cm. lata.

Flores solitarii oppositifolii longe pedunculati patentes. Pedunculi rigidi 2–3 cm. longi dense tomentosi, tertio superiore 3 bracteis linearibus 6–8 mm. longis muniti. Calyx tubuloso-campanulatus basi attenuatus, trilobatus lobis rotundatis obtusis vel acutiusculis, 16–18 cm. longus, extus minute pilis sublepidoto-stellulatis vel fasciculatis dense adpresseque munitus, pallide brunneo-viridis intus lutescenti-albus dense villosus. Petala obovato-spathulata, parte media inferiora angustata, 25 mm. longa x 9–10 mm. lata, alba, supra glabra extus pubescentia. Staminorum columna calice duplo longior glabra sed parte superiori sparsissimis pilis munita, 4 cm. long. extremo in 5

[1]Adonsonia **10:** 146 (1873), Histoire des Plantes **4:** 155 (1873).

[2]Vischer, "Sur les *Quararibea* Aubl.," Bull. Soc. Bot. Genève **11:** 199 (Genève 1919).

laciniis antheriferis linearibus 8–10 mm. longis producta; laciniis 6 polliniferis saccis oblongis 2 mm. long. distantibus. Stylus dense villosus antherarum laciniis parum brevior.

Pedunculi fructiferi (n° 21141) 9–10 cm. longi. Calyx fructiferus cupuliformis margine irregularis, coriaceus brunneo-viridulus dense adpresseque tomentulosus, 18 mm. long. x 18–20 mm. lat. Fructus 2.5–3 cm. longus drupaceus in sicco induratus, ovatus obtuse apiculatus plus minusve velutino-tomentosus pallide brunneo-viridulus; 5 pyrenis fusiformibus 16–17 mm. longis (saepe 2–3 prae abortione), monospermis. Semen 12 mm. long. rubescenti fuscum laeve glabrum.

Type: COLOMBIA, Dep. del Valle, Cordillera Occidental, vertiente occidental: Hoya del río Anchicayá, cerca del Puente de Aguaclara, 120 m. alt., 22-IX-1946 colect. J. Cuatrecasas 22086. "Arbol 15 met. alt. Tallo 30 cm. diam. Corteza gris, sección ocrácea, semidura. Hoja coriácea, verde clara. Capullos y cáliz sepia verdosos. Pétalos blancos." (F.).

Cotype: COLOMBIA, Dep del Valle, Río Calima (región del Chocó): margen izquierda, bosques junto a la Quebrada de la Brea, 25–45 m. alt., 20-V-1946 colect. J. Cuatrecasas 21141. "Arbol 10 met. alt. Hoja membranosa, rígida, verde amarillenta. Pétalos ocráceos. Cáliz ocráceo verdoso, luego verde pardusco. Frutos maduros 35 mm long., 30 mm. lat., dehiscentes en 5 partes semiblandas, monospermas." (F.).

Q. leptandra can be distinguished from all other species by its long pedunculate flowers and fruits, by the size of the fruit and especially by the morphology of the androeceum characterized by a long glabrous staminate tube and very narrow linear anther bearing segments with remote paired pollinia sacs.

Quararibea putumayensis Cuatr., sp. nov.

Arbuscula. Rami terminales ochraceo virides.

Folia subcoriacea alterna integra petiolata glabra. Petiolus robustus 6–16 mm. long. peridermato rugulosus. Lamina elliptico-lanceolata basim versus attenuata, apice attenuato apiculato; margine laevis vel leviter sinuata; nervo medio notato subtus eminenti; nervis secundariis 4–5 utroque latere arcuato-ascendentibus in angulo obtuso, basi dispositione triplinervis, 13–30 cm. long. x 4.5–11 cm. lata. Stipulae lineares lanceolatae acutae, 10 mm. longae.

Pedunculus 3 cm. long. Calyx coriaceus, tubuloso-campanulatus 2 cm. longus, 4–5 dentibus triangulari-obtusis vel acutiusculis, intra sericeo-villosus extus ochraceo-viridibus dense minutis pilis sublepidoto-stellulatis tomentoso obtectus. Petala 28–30 mm. long. x 9–10 mm. lat. alba, elliptico-spathulata, basi in ungue angustata, extus villosa, supra parce pubescentia. Androcei tubulus valde exsertus, circa 5 cm. longus in 5 laciniis antheriferis linearibus obtusis, 6.5–8 mm. longis, partitus; antheris 6 lobulis polliniferis bilocularibus oblongis.

Fructus (Schultes 3709) longe pedunculatus pedunculo 4.5 cm. longus in 5 laciniis antheriferis linearibus obtusis, 6.5–8 mm. longis, irregularibus. Fructus subdrupaceus, in sicco induratus globosus depressus oscure tetragonus vel pentagonus, obtuse acuminatus dense

tomentulosus brunneo-viridis, saepe 5 loculis monospermis vel prae abortione minus, 2.5 cm. longus, 3 cm. latus.

Type: COLOMBIA, Comisaría del Putumayo; selva higrófila del rio Putumayo: Puerto Porvenir, arriba de Puerto Ospina, hacia La Loma 230–250 met. alt., 19-XI-1940 colect. J. Cuatrecasas 10686 (F.). Additional specimens: in the same region collected in 1941 by R. E. Schultes 3709. Peru, Dep. Loreto: Soledad on Rio Itaya, alt. ±110 met., dense forest Sept. 1924 collect. E. P. Killip and A. C. Smith 29727 (F.) "Tree 30–40 ft., fruit brown." Colombia, Com. Putumayo: Umbria, 325 m. alt., forest, dec. 1930 collect. G. Klug 1881.

Quararibea lomensis Cuatr., sp. nov.

Species quam *Q. putumayensis* nunc descripta folia similia sed nervatio majis elevata.

Fructi breviter pedunculati; pedunculi tomentosi 1–1.5 cm. longi apice tribus bracteis persistentibus muniti. Calyx fructiferus coriaceus cupuliformis 4 lobulis plus minusve profundis 14–18 mm. altus. Fructus ovato-subpyriformis apiculatus, 25–28 mm. longus, 12–15 mm. latus, subdrupaceus, mesocarpio fibroso epicarpio adpresse tomentoso; 4–5 seminibus 10–11 mm. longis.

Type: COLOMBIA: Comisaría del Putumayo, selva higrófila del río Putumayo, Puerto Porvenir arriba de Puerto Ospina, hacia La Loma, 230–250 met. alt., 19-XI-1940 colect. J. Cuatrecasas 10686-A. (F.).

Quararibea inaequilatera Cuatr., sp. nov.

Arbor 15–20 met. alta. Folia grandia alterna subcoriacea petiolata. Petiolus rigidus stellato-tomentosus 7.5 cm. longus. Lamina oblique ovato-elliptica valde inaequilatera 31 cm. long. x 19 cm. lata, apice rotundata obtusa vel leviter apiculata basi satis profunde emarginata uno latere anguste lobato truncato, altero lobo rotundato valde longiori; margine irregulariter sinuata; supra viridis glabra tantum costa nervisque leviter puberulis; subtus dense stellato tomentosa. Decem nervi palmato radiati elevati sed costa et duo nervi laterales reliquis crassiores et majis prominentes; nervi secundarii 7 utroque latere ascendentes; nervuli transversales reticulati.

Fructi caulinares. Pedunculi robusti 2 cm. long., parce piloso. Fructus subdrupaceus pyriformis 2.5–3 cm. longus adpresse stellato tomentosus viridi-brunneus, 5 locularis, 5 spermis. Semina 12 mm. longa.

Type: COLOMBIA, Comisaría del Putumayo, selva higrófila del río Putumayo: Puerto Porvenir, arriba de Puerto Ospina hacia La Loma, 230–250 m. alt. 17-XI-1940 colect. J. Cuatrecasas 10624 (F., H.N.C.).

Closely related to the other species of this genus with asymmetrical leaves, *Q. obliquifolia* (Standl.), *Q. inaequalis* (Dugand) and *Q. asymmetrica* (Cuatr.), it differs from all of them in the form of the fruit which is not rotund but pyriform and shorter than in two of these species, in the cupuliform calyx surrounding the fruit, and in the tomentose lower side of the leaf. In spite of lack of flowers these characters clearly mark this new species.

Quararibea sulcata Cuatr., sp. nov.

Arbuscula 1–3 met. caule tenui.

Folia alterna grandia membranaceo-coriacea integra petiolata. Petiolus 14 cm. long. rigidus robustus, infra limbo incrassatus, tomentulosus. Lamina ovato-elliptica, basi rotundata apice attenuata in acumine elongata, 50 cm. long. x 30 cm. lata; margine laevis; supra pallido viridis sublaevis glabra nervis notatis subtus pallido viridis nervatione valde elevata leviter pubescens sparsis pilis stellatis; nervo medio valde prominenti, lateralibus elevatis 9 utroque latere arcuato ascendentibus reliquis nervis laxe reticulatis. Stipulae lanceolatae coriaceae caducae, 12–14 mm.

Fructus pendulus, globosus apice depressus, basi tantum leviter attenuatus 5-sulcatus, 5 cm. long., 7 cm. lat. Pericarpium maturitate viridi-lutescente tomentosum laeve carnosum, in sicco anguste membranaceum endocarpio adpressum ruguloso-striatum. Endocarpium 5 pyrenis monospermis. Semina 2.5 cm. longa. Calyx persistens coriaceus fissus.

Type: COLOMBIA, Dep. del Valle; Cordillera Occidental, vertiente occidental: Hoya del río Sanquininí, lado izquierdo: La Laguna, bosque 1250–1400 m. alt., 10–20 dic. 1943 colect. J. Cuatrecasas 15650. "Arbolito 1–3 met. Hoja muy grande coriáceo papirácea, verde clara, envés muy pálido. Fruto colgante con cinco surcos longitudinales. Pericarpo blando amarillento verdoso, tomentoso, en el ápice deprimido, 5 cm. long. x 7 cm. lat. Cáliz coriáceo, persistente, ocráceo verdoso." (F.).

This species is well characterized by the structure and size of its leaves, perhaps the largest in the genus, and by its peculiar fruit which is depressed and marked with 5 longitudinal channels, resembling that of *Q. lecytifolia;* otherwise a very distinct species.

Quararibea samariensis Cuatr., sp. nov.

Arbor mediocris. Rami cortice viridi-grisei.

Folia alterna integra coriacea. Petiolus 8–15 mm. longus rigidus tomentulosus. Lamina elliptica basi rotundata apice rotundata subite apiculata vel obtusa vel interdum emarginata, margine laevis vel irregulariter sinuosa, nervo medio valde elevato, nervis lateralibus 4 utroque latere arcuatis ascendentibus margine approximatis, 7–11 cm. longa x 3–5 cm. lata; supra subnitida glabra; subtus pallido-viridis glabra vel juxta nervos sparsis pilis stellatis munita.

Fructus cuneato-subglobosus depressus, in sicco 3 cm. diam., dense adpresseque tomentulosus, pallido viridi-brunneus. Mesocarpium fibrosum induratum. 2–3 loculis monospermis prae abortione (ovarium 5-loculatum). Calyx persistens coriaceus depresse caliciformis brunnescens adpresse tomentosus, quam fructus dimidio brevior.

Type: COLOMBIA, Dep. Norte de Santander. Cordillera Oriental: Hoya de Samaria (Municipio de Toledo) 2000–2100 m. alt. 30-X-1941 colect. J. Cuatrecasas et R. E. Schultes et E. Smith 12789 (F.).

Although lacking flowers these specimens represent a very characteristic new species, on account of the form, shape and texture of the leaves as well as of the form and size of the fruit.

Quararibea Bolivarii (Cuatr.) subsp. **occidentalis** Cuatr., subsp. nov.

Arbor 20 met. alta. Caulis 30 cm. diam. Rami horizontales folia pendula ferentes, cortice griseo vel griseo-badio plus minusve peridermato squamoso, juvenilium terminationibus tomentosis badiviridibus.

Folia grandia subcoriacea alterna integra pallido-viridia subtus pallidiora petiolata. Petiolus robustus 2–3 cm. longus adpresse tomentosus. Lamina oblonga obovato-lanceolata longe basim versus attenuata basi cuneata, apice attenuata acuta saepe apiculata (apiculo ad 3 cm. long.), 30–60 cm. long. x 10–15 cm. lata; margine integra vel leviter sinuata; nervo medio satis crasso, 6–7 nervis secundariis utroque latere distantibus angulo acuto, duo inferiores et medius basi dispositione triplinervis, inter eos nervulis laxo reticulo; supra sparsis fasciculatis

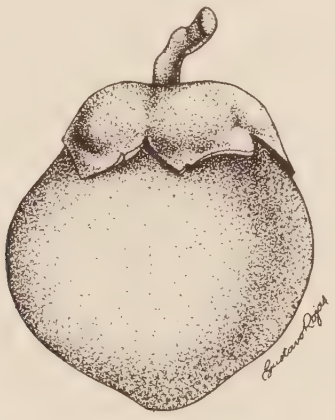

FIG. 1. *Quararibea Bolivarii* subsp. *occidentalis* Cuatr. Fruit one-half natural size.

pilis infra copiosis. Stipulae deciduae coriaceae lanceolatae, 2 cm. x 4.5 mm. lat., dense tomentosae fusco-viridulae.

Floralium pedunculi oppositifolii erecti robusti, dense fasciculato-tomentosi 2–3 cm. longi tertio superiore tribus bracteolis crasso-coriaceis ovato-acutis vel lanceolatis, 15–20 mm. long. x 8–12 mm. latis muniti. Calyx tubuloso-conicus, crasso-coriaceus 3–3.5 cm. longus, 3 lobis rotundatis et 4–5 dentibus, extus fuscoviridis densissime tomentosus, intus dense villoso-sericeus nitidus. Petala spathulata oblonga 35–40 mm. longa x 8–10 mm. lata obtusa, eburnea, intus sparsis simplicibus pilis, extus adpresse stellato-tomentosa, basi glabra. Staminorum tubus crassus exsertus, praeter basim glabram dense tomentosus 17 mm. longus, apice apertus et palmatifidus; 5 lobulis antheriferis 10–12 mm. longis late linearibus 5–6 polliniferus loculus ferentibus. Stylus staminorum tubum aequilongus, hirsutus stigmate prismatico-capitato obscure 5-lobato.

Fructus 7–8 cm. diam. dense adpresseque tomentosus viridi-fuscus, globoso subapiculatus vel apice truncatus vel interdum depressus. Mesocarpium crassum fibrosum denique induratum. Endocarpium

lignosum quinquelocularibus, 5 spermis. Semina 2.5 cm. longa, sectio triangularia epispermo fusco nitido. Calyx accrescens coriaceus inaequalis disciformis.

Type: COLOMBIA, Dep. del Valle, Cordillera Occidental, Hoya del río Cali lado derecho del río Pichindé, en La Palma 2500 met. alt., 24–VII-1946 colect. J. Cuatrecasas 21685. "Gran árbol con ramas horizontales. Hoja larga péndula, verde amarillenta, más clara en el envés. Cáliz coriáceo pardusco verdoso. Pétalos color blanco crema. Androceo saliente id. color." "sapote de monte." (F.).

This plant, which at first sight appears to be a different species, is a geographical variant of *Q. Bolivarii* Cuatr., known only from the Oriental Cordillera and without fruit. Subspecies *occidentalis* is a polymorphic entity which grows in the forest of the West Cordillera. Although not very common, this *Matisia* is very remarkable for its typical form; it is a medium sized tree whose few horizontal branches bear large, hanging leaves; the flowers are actinomorphous and generally borne vertically on the upper side of the branches in opposite direction to the leaves. This subspecies is distinguished from its closest relatives by its large, tomentose leaves, which are larger and narrower towards the base than in *Q. Bolivarii*. The flowers and peduncles are longer too. The bracts are broad, three of which are generally disposed at the base of the flowers like a calycle. When ripe and dry, the fruits are very hard; they have 5 cavities, each containing one seed; upon decay 5 nuts formed by the ligneous endocarp are set free. These fruits are similar to those of *Q. Castano*, but are smaller, more depressed and provided with a harder mesocarp. Although these fruits may be transported for long distances near rivers, this method of dispersal does not facilitate the distribution of the species along the Cordillera, for these rivers are only short transversal routes.

Quararibea Bolivarii subsp. **occidentalis** var. **latifolia** Cuatr., nov. var.

Folia coriacea antea subspecie descripta latiora et breviora, elliptica vel ovata basi rotundata vel subrotundata, triplinervia vel subquintuplinervia, 27–40 cm. longa x 15.5–21 cm. lata; petiolo pedunculisque longioribus (3–5 cm. longis).

Type: COLOMBIA, Dep. del Valle; Cordillera Occidental: Hoya del río Cali, lado derecho del río Pichindé en La Palma, 2500 m. alt., 24-VII-1946 colect. J. Cuatrecasas 21683. "Arbor 10 met. alt. con ramas horizontales. Hojas coriáceas verde amarillento oscuras. Cáliz coriáceo verde amarillento claro. Pétalos blanco amarillentos. Anteras amarillo pálidas." "sapote de monte" (F.).

Additional specimens examined: Id. Hoya del río Cali, río Pichindé entre Quebrada de Juntas y El Recreo 2070–2260 m. alt., 7-VIII-1946 colect. J. Cuatrecasas 22001. "Arbol 15 met. alt., 30 cm. diam., Corteza rugulosa, algo agrietada superficialmente sección gruesa, ocrácea. Madera semiblanda, blanquecina. Hoja coriácea verde amarillenta haz verde cenicienta envés. Cáliz ocráceo pardusco. Pétalos blanco ocráceos." "sapote." This number is a form with narrower leaves, but clearly rotundate base; it is an intermediary form between the subspecies and the variety.

Quararibea Bolivarii subsp. **occidentalis** var. **lignocarpa** Cuatr., nov. var.

Fructus maturitate in sicco mesocarpio valde indurato lignoso; epicarpio dense tomentoso velutino fuscescenti. Folia satis oblonga elliptico lanceolata apice attenuata, basi angustata triplinervia vel rotundata subquintuplinervia.

Type: COLOMBIA, dep. del Valle, Cordillera Occidental, filo de la Cordillera al N de Las Brisas: Carrizales. 2200–2250 met alt., 25-X-1946 colect. J. Cuatrecasas 22554. "Arbol 10 met. alt. con ramas horizontales o inclinadas. Hojas péndulas, coriáceas o verde amarillento claras. Frutos esferoideos, parduscos, 7–8 cm. diam. "Sapote de monte." (F).

Quararibea alata (Little) Cuatr., nov. comb.
Matasia alata E. L. Little, Journ. Wash. Acad. Sci. **38:** 100 (1948).

Quararibea amplifolia (Pittier) Cuatr., nov. comb.
Matisia amplifolia Pittier, Bol. Soc. Venez. C. Nat. **10:** 115 (1945).

Quararibea asymmetrica (Cuatr.) Cuatr., nov. comb.
Matisia asymmetrica Cuatr., Rev. Acad. Col. C.E.F.N. **7:** 49 (1946).

Quararibea bicolor (Ducke) Cuatr., nov. comb.
Matisia bicolor Ducke, Arch. Jard. Bot. Rio Janeiro **3:** 210 (1922).

Quararibea Bolivarii (Cuatr.) Cuatr., nov. comb.
Matisia Bolivarii Cuatr., Ciencia, **1:** 401 (1940).

Quararibea bracteolosa (Ducke) Cuatr., nov. comb.
Matisia bracteolosa Ducke, Bol. Tec. Inst. Agr. N. Belem **4:** 17 (1945).

Quararibea Castano (Karsten et Triana) Cuatr., nov. comb.
Matisia Castano Triana et Karsten, Ann. Sc. Nat. Ser. IV. **27:** 326 (1862).

Quararibea coloradorum (Benoist) Cuatr., nov. comb.
Matisia coloradorum R. Benoist, Bull. Soc. Bot. Fr. **80:** 335 (1933).

Quararibea Cruceto (Cuatr.) Cuatr., nov. comb.
Matisia Cruceto Cuatr., Rev. Acad. Col. C.E.F.N. **6:** 550 (1946).

Quararibea grandifolia (Little) Cuatr., nov. comb.
Matisia grandifolia Little, Journ. Wash. Acad. Sci. **38:** 102 (1948).

Quararibea hirta (Cuatr.) Cuatr., nov. comb.
Matisia hirta Cuatr., Rev. Acad. Col. C.E.F.N. **6:** 550 (1946).

Quararibea lecythicarpa (Ducke) Cuatr., nov. comb.
Matisia lecythicarpa Ducke, Bol. Tec. Inst. Agr. N. Belem **4:** 18 (1945).

Quararibea longiflora (Gleason) Cuatr., nov. comb.
Matisia longiflora Gleason, Phytologia **1:** 26 (1933).

Quararibea sclerophylla (Cuatr.) Cuatr., nov. comb.
Matisia sclerophylla Cuatr., Rev. Acad. Col. C.E.F.N. **6:** 549 (1946).

Hampea albipetala Cuatr., sp. nov.

Arbor 3 met. alta. Caulis 80 cm. diam. Rami terminales viridi-grisacei tomentosi.

Folia membranacea; lamina ovato-acuta, basi rotundata vel truncata vel cuneata, apicem versus attenuata apice acuta vel subapiculata, 18–23 cm. long. x 10–14 cm. lata; supra viridis plus minusve nitida, sparse stellato-pilosa et sparsissime calloso punctata; subtus stellato-piloso-tomentosa, quintuplinervia, tribus nervis centralibus quam externis marginem approximatis, crassioribus, reliquis conspicue reticulatis; margine integra laevis vel sublaevis; petiolus 6–7 cm. longus, erectus dense tomensus pilis stellatis adpressis, pallide viridi-griseus in vivo, brunneus in sicco.

Flores in glomerulis umbelliformibus axillaribus 6–12 floribus, copiosis; pedunculi patentes rigidi erecti dense stallato tomentosi 1–2 cm. longi. Bracteae 3, triangulares acutae breves ad basim calycem adpressae. Calyx ovatus 8–9 mm. long, irregulariter 3–4 dentatus lobulis obtusis extus dense stelullato tomentosus pallido-viridi-grisaceus. Corolla alba contorta, 25–30 mm. long., tubulo angusto 4 mm. longo glabro. Petala elliptico lanceolata 6–8 mm. lata basi margine externa auriculata, apice acutiuscula vel obtusa, extus basi hirsuta reliquo stellato tomentosa, intus glabra. Stamina quam petala breviora filamentis albis glabris, circa 60. Antherae pallido luteae. Pistili rudimentum lineare hirsutum.

Type: COLOMBIA, Dep. del Valle: Hoya del rio Dígua, lado izquierdo: Piedra de Moler, bosque 980–1020 m. alt., 19-VIII-1943 colect. J. Cuatrecasas 14908. "Arbol grande, 30 m. alt., Tallo grueso blanquecino, 80 cm. diam. Madera floja, blanca. Cáliz verde-grisáceo claro. Corola y filamentos estaminales blancos. Anteras amarillo pálidas." (F.).

This species differs from *H. thespesioides* Tr. et. Pl. Chiefly by its leaves, which are truncate or round at the base rather than cordate, and by its larger flowers. The petals are much longer and auriculate in the base. The flowers are white and not yellow. From *H. panamensis* Standl. it is distinguished by its tomentum and by the absence of the auricules of leaves.

CUNONIACEAE

Weinmannia lopezana Cuatr., sp. nov.

Arbor 6 met. alta. Rami cortice griseo-fusci. Ramuli terminales foliosi ferrugineo-tomentosi.

Folia opposita imparipinnata subcoriacea 1.5–2.5 cm. longa, 2–3 juga. Petiolus hirsutus brevis, 1–2 mm. long. Foliola obovato-elliptica 4–8 mm. longa, 3–5 mm. lata apice rotundata basi cuneata vel subcuneata, margine supra partem mediam vel tertiam, serrato crenata; supra glabra nitida viridia; subtus subnitida pallidiora 3–4 tenuibus nervis utroque latere conspicuis nervo medio plus minusve pilosis reliquum glabra, terminalia quam lateralia aequilonga vel subaequilonga. Internodia subtus et commisuris pilosa, alatis aliis obovato oblongis. Stipulae ovato cordatae 2.5–5 mm. longae et latae supra glabrae infra sparse pilosae, subcoriaceae persistentes.

Pseudoracemi oppositi terminales globosi vel oblongi, 7–15 mm. longi, pedunculo tomentoso 5–12 mm. longo, bracteolis oblongis obtusis 0.1 mm. longis. Flores congestae. Pedicelli 1–2 mm. longi hirti. Calyx glaber 1.5 mm. long. sepalis ovatis. Petala suborbicularia rubescentia glabra 2 mm. long. Filamenta glabra 3.5 mm. longa. Ovarium glabrum.

Types: COLOMBIA, Departamento del Cauca; Cordillera Central, vertiente occidental; Cabeceras del río Palo, quebrada del río López; Alto del Duende, matorrales y bosquecillo de páramo, 3300–3350 met. alt., 1-XII-1944 colect. J. Cuatrecasas 18835 (F. US.). Additional specimen: Departamento Caldas: Cordillera Central, vertiente occidental vertiente SW del Ruíz: Termales 3400 met. alt., 4-V-1940 colect. J. Cuatrecasas 9220 (F., US, HNC).

W. lopezana is well characterized by its persistent stipules and umbelliform-globose or short pseudo-racemose inflorescences, similar to those of *W. brachystachya* Willd. However, it differs from this species by its larger and broader leaflets, which are flat, veined and hairy below along the midrib.

Weinmannia queremalensis Cuatr., sp. nov.

Arbor 10 met. alta. Rami cortice fusco griseo terminationibus foliosis ferrugineo-viridibus tomentosis.

Folia subcoriacea opposita integra obovata apice rotundata vel obtuse attenuata basi attenuato-cuneata breviter petiolata. Petiolus 2–8 mm. longus tomentosus. Lamina 5–10 cm. longa x 3.5–7 cm. lata, margine argute serrata, supra atro-viridis sparse puberula nerviis tomentulosis, infra pallido viridis pubescens nervo medio valde eminenti nervis lateralibus vulgo 12 utroque latere angulo obtuso, reliqua subtilibus venulis reticulatis. Stipulae obovato ellipticae 12 mm. longae, 9 mm. latae supra glabra subtus villosa.

Pseudo-racemi oppositi terminales et subterminales floriferi 8 cm. longi fructiferi ad 15 cm. long. Axis tomentuloso-hirtus. Bracteolae ovate 1–1.5 mm. long. Pedicelli teneres villoso-hirti alabastriferi 2 mm. longi, fructiferi 7 mm. longi. Sepala ovato triangularia viridia apicem parce hirta. Petala in alabastra albo rosea suborbiculata margine gracilior ciliata.

Capsule rubescentes elliptico lanceolatae minute et sparse pilosae, 3–4 mm. longae.

Type: COLOMBIA, Departamento del Valle; Cordillera Occidental, vertiente occidental; Hoya del río Dígua, lado izquierdo del río San Juan en la región de Queremal, 1540–1650 met. alt., Quebradita del Km. 51, 25-II-1947 colect. J. Cuatrecasas 23723 (F., Valle, US.).

W. queremalensis is closely related to *W. Lehmannii* Hieron. and *W. latifolia* Presl., as the leaves of these three species are hairy on both sides, but for this reason different from the *W. Balbisiana* HBK. complex. *W. queremalensis* differs from its nearest relatives especially by the long inflorescences and pedicels and by the oblong and narrower capsules. Besides, *W. latifolia* is more pubescent and the nerves are more prominent on the lower side of the leaves. In *W. queremalensis* the ovary or the young capsules are puberulent. *W. caucana* Killip, another closely

related species, has different leaves, is less hairy and has a different inflorescence.

Weinmannia Jahnii Cuatr., sp. nov.

Arbuscula 5–6 met. alta. Rami griseo fusci glabrescentes terminales tomentoso-hirsuti.

Folia imparipinnata opposita membranacea vel subcoriacea plerumque 8 paribus foliolis 10–15 cm. longa. Petiolus 15–25 mm. longus hirsutus supra glabratus. Rachis supra sulcatus utrinque hirsuto-tomentosus. Foliola elliptica vel elliptico oblonga, basi subrotundato-cuneata apice subrotundata vel obtusa, margine serrulata leviter revoluta, supra puberula costa et nervis secundariis impressis reliquo reticulato venosa, infra hirsutula nervo medio eminenti secundariis 6–7 paribus ascendentibus valde signatis, inter eos lamina leviter bullata, 15–30 mm. long. x 10–16 mm. lata apicem et basim versus paulo gradatim minora terminalium quam adjacentes longiora elliptico lanceolata. Internodia ovato-oblonga superiora 5–6 mm. lata basim versus gradatim angustiora nervis lateralibus inconspicuis. Stipulae ellipticae latae, supra glabrae, extus hirsuto-tomentosae.

Pseudoracemi subterminales. Axis tomentoso-hirsutus 11–14 cm. longus. Pedicelli teneres patentibus hirti 4–8 mm. longi. Bracteolae lineares 1–2 mm. longae. Sepala anguste triangularia hirta 1 mm. longa. Petala elliptica 2 mm. longa glabra. Stamina 3 mm. longa. Ovarium tomentoso-hirsutum. Capsula oblonga 2.5–3 mm. longa, tomentoso-hirsuta.

Type: VENEZUELA: En la selva arriba de Palmira, vertiente septentrional de la Cordillera de Mérida 2500 met. alt. IX-1921 colect. Alfredo Jahn 536. "Tree 5–6 mm." (US.). Additional specimen: VENEZUELA: Páramo del Molino 2600 m., Mérida, 21-I-1922 colect. Alfredo Jahn 929 (US.).

W. Jahnii, until now confused with *W. pubescens* HBK., is also related to *W. glomerata* Presl., but can at once be distinguished from the latter by the densely tomentose ovary and capsule; besides, the veins are less prominent.

Weinmannia costulata Cuatr., sp. nov.

Arbuscula usque 12 met. alta. Ramuli fusco rubescentes glabri vel glabrescentes ultimis internodiis elongatis pubescentibus.

Folia imparipinnata opposita membranaceo-coriacea, 10–24 cm. longa 7–10 juga. Petiolus 15–20 mm. longus robustus hirsuto-tomentosus. Rachis supra sulcatus utrinque tomentoso-hirtus. Foliola elliptico oblonga basi rotundato cuneata apicem attenuata acuta, vel inferiora obtusiuscula margine argute serrata anguste revoluta, supra glabra subnitida costa costulaque profunde impressa, subtus costa valde eminentis villosa nervis secundariis 12–14 utroque latere angulo obtusissimo valde costulato-prominentibus villosulis inter eos reliqua lamina glabra satis bullato-depressa, 22–55 mm. long. x 13–18 mm. lat., inaequalia, apicem et basim versus gradatim minora terminalium quam adjacentia longius elliptico-lanceolatum. Internodia late ovalia superiora usque ad 9 mm. latitudinem basim versus gradatim angustiora,

nervis lateralibus perpendicularibus valde signatis. Stipulae orbiculatae-ellipticae intus glabrae extus villosae. Pseudoracemi per paribus pedunculatis oppositis; pedunculi compressi tomentoso hirtuli, 3–5 cm. longi. Axis tomentuloso-hirtulus 10–18 cm. longus. Pedicelli teneres 3–6 mm. long., fructiferi 6–8 mm. longi, puberuli. Bracteolae minutae lanceolatae. Sepula anguste ovato-triangularia 1,5 mm. longa glabra. Petala elliptica alba 2 mm. longa. Stamina longiora glabra. Ovarium glabrum. Capsula immatura ovato acuminata 3 mm. longa.

Type: ECUADOR; prov. Santiago-Zamora: dense forest between Campanus and Arenillas, along Rio Tintas, 10 leagues southeast of El Pan, altitude 2195 meters, July 13, 1943, J. A. Steyermark 53545, "sarrar." "Shrub to small tree 15–40 feet tall; flowers white. Along Rio Tintas below Arenillas." (F.).

Additional specimen: ECUADOR: prov. Santiago-Zamora dense forest between Campanas and Arenillas, along Rio Tintas, 10 leagues southeast of El Pan, altitude 2195 m., July 13, 1943, collect. J. Steyermark 53559. "Tree 35 feet tall. In valley at Arenillas along Rio Tintas below Arenillas in zone of Cinchona "rosada." Specimen with gigantic, elliptic-lanceolate leaflets to 12 cm. long, the terminals to 17 cm. long. In spite of what the label says, I regard this number as an oversized juvenile individual.

Closely related to *W. glomerata* Presl., *W. costulata* differs from it in having long pedicellate flowers. Besides, *W. glomerata* has fewer and obtuse leaflets, which are more pubescent on the lower side, and a puberulent calyx.

Weinmannia cochlearis Cuatr., sp. nov.

Arbor 6–7 met. alta. Rami fusco-grisei rugulosi glabri. Ramusculi glabri brunneo-rufescentes.

Folia opposita coriacea rigida simplicia. Petiolus 2–5 mm. longus supra sulcatus vel planus, glaber, subtus hirtus. Lamina ovato elliptica vel ovato orbicularia basi rotundata vel truncata vel subcordata apice rotundata vel obtusa, valde concavo-curvata cochleariformis, margine serrata revoluta, supra glaberrima viridis, subtus nervo medio valde eminenti hirsutulo nervis secundariis 7–9 utroque latere satis prominentibus plus minus pilosulis, reliqua superficie inter nervationem glabra depresso-bullata, reticulo venulorum minusculo notato 2–5.5 cm. long. x 1.5–4 cm. lat. Stipulae orbiculari-ellipticae 5 mm. longae, utrinque glabra sed apice margine ciliolulatae, vel extus sparsissimis pilis munitae.

Pseudoracemi oppositi subterminales, fructiferi 8 cm. longi. Axis rubescens glabrescens, sparsis pilis munitus. Pedicelli fructiferi 5 mm. long., teneries minutis sparsis pilis. Sepala lanceolata glabra. Capsula rubescens vel rubra, elliptico elongata 5–5.5 mm. longa, stylis persistentibus 2.5 mm. longis.

Type: ECUADOR, prov. Azuay: between Huagrarancha and Loma de Galapagos, alt. 3140–3505 m., collect. ju19, 1943, J. A. Steyermark 53455. "Tree 20 feet tall; leaves revolute, coriaceous, deep green above; peduncles and flowers lavender-rose. On narrow ridge," "sarrar." (F.).

This species is related to *W. testudineata* Cuatr. from northeastern Colombia. Both species have simple coriaceous and concave leaves, which are turtle-shaped and provided with prominent nerves. The specimen collected by Steyermark is distinguished by its coriaceous and larger leaves, which are glabrous and hairy only on the upper and lower side of the midrib and base of the laterals; the stipules are glabrous on both sides or bear isolated hairs on the lower side; the branches and branchlets are glabrous, while the axis of the inflorescence is sparsely covered with hairs (whereas in the Colombian species the last internodes of the branchlets, axis and pedicels are hirsute); the calyx is completely glabrous; the capsule is longer than 5 mm. whereas that of *W. testudineata* is only 3 mm. long (the measurement in the original description is wrong).

Weinmannia Cardonae Cuatr., sp. nov.

Arbor ramis glabris fusco-griseis. Ramusculi terminali foliosi compressi grisei glabri.

Folia rigidae coriacea opposita simplicia integra petiolata glaberrima. Petiolus glaber 3 mm. longus. Lamina obovata vel obovato oblonga apice rotundata basi cuneata margine revoluta sinuato obtuseque serrata; supra nitidissima viridis nervo medio impresso, lateralibus leviter conspicuis; subtus pallida nervo medio elevato, nervis lateralibus utrinque 9–11 prominulis angulo obtuso reliquis nervulis venulisque parum inconspicuis, 2.5–4 cm. long. 15–20 mm. latae. Gemae stipulaeque glabrae.

Pseudoracemi oppositi 2.5–4 cm. longi. Axis striatus sparsissime pilosulus. Bracetolae triangulares minutissimae. Pedicelli minute sparseque pilosi 1–2 mm. longi. Sepala 1 mm. rigide ovato-triangularia glabra. Petala 1.5–2 mm. long. oblonga margine plerumque laceratociliata. Stamina aequilonga vel paulo petala superantia. Capsula glabra ovato-oblonga apicem versus angustata, 2.5–3 mm. longa.

Type: VENEZUELA, Edo. Bolívar: Cumbre del cerro Apacará, rio Caroní, 2100 met. en bosques, 8-VII-1946 colect. F. Cardona 1559 (US).

Additional specimen: VENEZUELA: orilla del río Caroní en lugares abiertos y rocosos frente al cerro Arabayen, Guayana 420 m. Arbol 10 m. alt., 21-IX-1946 colect. F. Cardona 1653 (US). This collection has larger (8 x 4.5 cm.) and more crenate leaves, long fructified inflorescences (up to 11 cm. long) and fruits (3.5–4 mm. long).

Weinmannia pinnata L., System. ed X, 1005, 1759.

W. glabra L. f., supl. 228, 1781.

I have examined abundant material of this species and related forms from West Indies, Central America, Venezuela and Colombia, kindly lent for study by the Smithsonian Institution and the New York Botanical Garden, besides the rich collection of Chicago Natural History Museum (F), and regard it as a highly polymorphic species of wide distribution. The type came from Jamaica and this form is different from that which grows on the other Antillean Islands, in Central America and Mexico. The other Antillean form agrees with the typical form of *W. hirta* Swartz, as Pampanini pointed out (Pamp., Annali Bot. **2:** 82).

Otherwise, the Jamaica plants are so similar to those from Venezuela considered *W. caripensis* HBK., that I think it is impossible to consider the last one specifically distinct from *W. pinnata* L. It can scarcely be considered a variety, as Engler did long ago (*W. glabra* var. *caripensis* (L.) Engler). I was able to compare recent material collected by J. Steyermark in the type locality of *W. caripensis* with types or isotypes of *W. nitida* Hieron., *W. nervosa* Killip and *W. antioquensis* Engler. In my opinion they are only varieties or forms of the highly plastic species *W. pinnata* L., which includes many intermediates. The Panama form is identical with that from Jamaica. *W. multijuga* Killip & Smith differs from *W. caripensis* by having leaves composed of more numerous and more rigid leaflets and long pedicels. But this is also a critical species because of its intermediate characters, for instance, Killip and Smith 15989 and 15987 with rigid and elliptical leaflets were referred to *caripensis*.

W. hirtella HBK., another closely related critical species, represents the same problem in relation to *caripensis* as does *W. hirta* with respect to *W. pinnata* L.

Consequently I propose the following synonymies:

Weinmannia pinnata L. var. **caripensis** (HBK.) Cuatr., nov. comb.

W. caripensis HBK., N. Gen. Sp. Pl., **6:** 58, 1823.
W. glabra var. *caripensis* (HBK) Engler.

VENEZUELA: Steyermark 62250 (topotype) (F). Steyermark 58733, 61534 and 56654 (F) fmas.

COLOMBIA: Cuatrecasas 12421, 13585 (HNC, W, F). Cuatrecasas 12785 and 10100 (HNC, W, F), fma., Cuatrecasas 23584 (Valle, W, F), fma.

Weinmannia pinnata L. fma. **nitida** (Hier.) Cuatr., nov. comb.

W. nitida Hieron., Engl. Bot. Jahrb. **20,** Beibl. 49: 23, 1895.

This form is distinguished by its narrow, long, oblong-elliptical or sublanceolate leaflets, which are more coriaceous than in the typical species and more lustrous on the upper side, and by its longer spiciform inflorescences. The low taxonomic status is prompted by the presence of intermediate forms. *W. antioquensis* Engler is approximately the same, except for its slightly larger leaflets.

Two other collections, Lehmann 4635 (type) (NY, W) and Triana (Fusagasugá) (NY) belong to this form. Toro 227 (Medellín) (NY, W) represents *antioquensis* (Engler) but has the same broader and hairy leaflets. I suspect that a series of hybrids between *W. pinnata* L. and *W. pubescens* HBK. will be found in the vicinity of Medellín.

Weinmannia pinnata L. var. **farallonensis** Cuatr., nov. var.

Rami terminales tomentulosi. Folia coriacea breviter petiolata 6–8-juga. Foliola elliptica 20–30 mm. longa 9–16 mm. lata terminalia lanceolata quam adjacentia fere duplo longiora, argute serrato-dentata, supra glabra, infra sparse pilosula nervo medio hirto. Internodia late rhomboidea. Rhachis utrinque hirtulo-tomentulosa. Stipulae

orbiculato-ellipticae ad 2 cm. longae supra glabrae infra villosae. Pedicelli hirti 2–5 mm. longi. Calyx glaber. Petala glabra. Ovarium glabrum. Capsulla ovato-elliptica 3 mm. longa.

Type: COLOMBIA, Dep. del Valle: Cordillera Occidental, Los Farallones, vert. NW, Quebrada del Ratón: Mina El Diamante, 2950–3000 m. alt., colect. 30-VII-1946, J. Cuatrecasas 21776. "Arbol. Hoja subcoriácea, flexible, verde brillante haz. Frutos rojizos." Id. Cuatrecasas 21776-A. (F.). Other specimen examined: Los Farallones, extr. N. vert. NW entre Alto del Buey y Quebrada de Los Ramos 3450–3350 m. alt., colect. 12-X-1944 J. Cuatrecasas 18050.

This variety recedes even more from related forms of *W. pinnata* and resembles *W. multijuga* Killip & Smith, but differs from the latter by tomentulose terminal branchlets, lanceolate terminal leaflet, deeply toothed leaflets, villose stipules and larger fruits.

WEINMANNIA BRACHYSTACHYA Willd. ex Engler, pro synon., Linnaea **36:** 606, 1869–1870. Pampanini, Annali de Bot. **2:** 70, 1904.

W. microphylla HBK., not R. et P., Nov. Gen. Sp. Pl. **6:** 54, 1823.
W. cochensis Hier., Engl. Bot. Jahrb. **20,** Beibl. 49: 22, 1895.

Weinmannia brachystachya Willd. var. **puracensis** Cuatr., nov. var.

Folia 1–3 juga foliolis majoribus obovato-elongatis. Capsula major.

Type: COLOMBIA, Dep. del Cauca; Cordillera Central; páramo del Puraceé, al sur del Volcán, en el filo de la Cordillera: San Francisco 3450–3400 m. alt. 23-VII-1943 colect. J. Cuatrecasas 14626. "Arbolito de copa muy compacta. Hoja verde brillante haz, ocráceo claro envés." (F.).

The leaves of this variety resemble those of *W. microphylla* R. et P., but the inflorescence is short umbelliform as in *W. brachystachya*, a fundamental character of this species. The fruits are a little longer than those of the plants studied by Hieronymus but are equal to the specimens collected by Humboldt and Bonpland. Certainly this species shows the polymorphism characteristic of the genus and the limited taxonomic importance of its variants.

WEINMANNIA LAXIFLORA Pampanini, Annali de Bot. **2:** 77, 1904.

I have examined an isotype of this species kindly lent by the New York Botanical Garden, and I regard it as a good species differing from *W. microphylla* R. et P. by its elongated leaflets. But *W. laxiflora* var. *polyphylla* Pamp. and fma. *minor* Pamp. are merely unimportant variants of *W. microphylla* R. et P.

WEINMANNIA MICROPHYLLA R. et P., Fl. Peruv. **4:** pl. 334, 1802.

W. parvifolia Ruiz ex Don, Edinb. New Phil. Journ. **9:** 89, 1830.
W. fagaroides HBK., Nov. Gen. Sp. **6:** 54, 1823.
W. Baccharíniana Pampanini, Annali de Bot. **2:** 81, 1904.
W. laxiflora var. *polyphylla* Pampanini, l. c.
W. tamana Cuatr., Rev. Acad. C.C.E.F. y N. **5:** 32, 1942.

All these epithets belong to the same species, *W. microphylla* R. et P., as pointed out by Macbride in his Flora of Peru. This species ranges from Peru to Bolivia north to Venezuela and the mountains of Guiana;

it is polymorphic and variable in size and number of leaflets, in the tomentum of the young branchlets and foliar rachis, and in the size of inflorescences and fruits.

Some Bolivian specimens have larger leaflets like *W. Engleriana* Hier. (Rusby 2040 (NY, US), Williams 849 (US, NY), Tate 358); others have larger fruits (Williams 849) and may well be hybrids. It is possible that they belong to v. *Weddellii* Macbr., the type of which I have not seen.

The Bolivian plants, *W. laxiflora* var. *polyphylla* Pamp. and fma. *minor* Pamp., doubtlessly belong to the R. and P. species; all have flat, toothed, elliptical, slender leaflets with thin veins which are prominent on the lower surface; the last internodes and rachis of the inflorescence are tomentose-hirtose and sometimes the foliar rachis and midnerves are also hairy.

The Equadorian and Colombian plants are generally more glabrous, while the terminal branchlets are barely covered by a shorter tomentum; the leaflets are shinier, frequently oblong, more coriaceous and dentate only near the tip. In northern Colombia (Norte de Santander) the leaves tend to be slender and shorter, the leaflets are smaller, the wings broader and the inflorescences shorter; the extreme of this form is represented by my *W. tamana*.

A variety with larger and stronger leaflets, var. *caracasana* (Pamp.) Cuatr., grows in Venezuela.

The following list includes those new combinations which I think can be admitted to this species, without attributing too much value to this systematic category.

Weinmannia microphylla R. et P. var. **typica** Cuatr.

W. microphylla R. et P., *W. parvifolia* Ruiz ex Don.

The following collections represent the typical form of the species:

BOLIVIA: Mandon 606 (NY), Bang 1085 (type of *W. laxiflora* v. *polyphylla* fma. *minor* Pamp.) (NY), Bang 669 (NY, US); O. Kuntze La Seja (NY, US); O. Buchtien 656 (US), 453 (NY); Balls 6281 (US), Cardenas 3104 (US); Szyszylowicz 294 (US).

PERU: Gay (fragm. in F); Pavon (frag. F); Pavon isotype of *W. parvifolia* ex Madrid Herb. (F).

ECUADOR: Bonpland, Loxa.

COLOMBIA: Killip et Smith 17930, 15734 (US, NY), Ariste Joseph 1921 (US), Perez Arbelaez et Cuatr. 8097 (US, HNC), Cuatrecasas 1265, 1749 (US, HNC), Cuatrecasas et Garcia B. 9724 (US, HNC). Pennell, cerro Tatama (fma., US).

Weinmannia microphylla R. et P.
var. **fagaroides** (HBK.) Cuatr., nov. comb.

W. fagaroides HBK., Nov. Gen. Sp. Pl. **6**: 54, 1823.

ECUADOR: Steyermark 53672 (F), Hitchcock 21518 (US, NY), Rose et P. et R. 22979 (US, NY), Lehmann 4981 (US, NY), 6595, Pentland 1092 (F, US), Bonpland, type fragm. from Paris (F).

VENEZUELA: Jahn 711 (US, NY), Funck 558 (F).

Weinmannia microphylla R. et P.
var. **tamana** (Cuatr.) Cuatr., nov. comb.

W. tamana Cuatr., Rev. Acad. C.C.E.F.y N. **5**: 32, 1942.

Killip et Smith 17747, 18656, 19590 (US, NY). Garganta 984 (F).

Weinmannia microphylla R. et P.
var. **caracasana** (Pampanini) Cuatr., nov. comb.

W. Baccariniana var. *caracasana* Pampanini, Annali de Bot. **2**: 82 (1904).
W. venezuelensis Killip et Smith, Bull. Torr. Bot. Cl. **56**: 371 (1929).

The type described by Killip and Smith differs considerably from the typical form of the Ruiz and Pavon species, and from the other Colombian forms (*tamana*, *fagaroides*) by its larger and stronger leaflets; but the discovery of intermediate forms necessitates treating this Venezuelan plant as a variety. The following collections are referred to it:

Curran et Haman 688; Tate 206, 205, 383, 461; Kuntze 1652; Pittier 6250 (type of *W. venezuelensis*), 8430 (US, F); L. Williams 12368; Delgado 237; Funk et Schlim 558 (F); Steyermark 62478, 55616, 56273, 62125; 61629 (forma) (F) Jahn 198, 938, 938-A (US).

COLOMBIA: Ariste Joseph A 95 (Verjón) (US). The plant of mount Duida, Tate 461, is a form with numerous rigid, oblong and obtuse leaflets.

WEINMANNIA BALBISIANA HBK., N. Gen. Sp. Pl. **6**: 51, 1823.

This species, based by Kunth on plants from Loxa, certainly belongs to a complex of forms ranging from Peru to Bolivia to eastern Venezuela. Killip and A. C. Smith in their study "The genus Weinmannia in northern South America" (Bull. Torr. Bot. Club **56**: 361–377, 1929) included in this species *W. Kunthiana* DC. and *W. lamprophylla* Diels, and suggested that *W. laurina* HBK., and *W. ovata* Cav. may also belong to this complex.

On the basis of the rich material I examined, I arrived at the conclusion that all forms of *Weinmannia* with simple, large, glabrous leaves (leaves, branches and terminal internodes) ranging from Peru to Guiana belong to one species. In this material it is possible to see all transitions between narrow (lanceolate) and broad leaves, short and long petioles, between ovate (nearly orbicular) and obovate leaves, between acute and obtuse forms. Size and consistency of leaves are also variable within certain limits, as are the length of the pseudo-racemes and that of the pedicels and capsules.

I consider *W. Balbisiana* the typical form of this complex because of its priority. I am unable to decide whether *W. ovata* Cav. should be included, as no recent collections of it are available. A fragment of the type in Chicago Natural History Museum (F) shows a character not evident in the rest of the collections examined by me, a marked delicate reticulation. According to Killip and Smith, a Peruvian plant from Cuzco, collected by Pennell (n. 14099) also shows this character and the sheet is labeled *W. ovata* Cav.; however, for the time being, I believe this character eliminates *W. ovata* from the *W. Balbisiana* complex.

The most common varieties of the polymorphic species *W. Balbisiana* sensu lato may here be considered. The lanceolate or elliptic-lanceolate, narrow leaved form represents typical *Balbisiana* (Peru) and *lamprophylla* Diels (Colombia), perhaps identical. A somewhat more broad leaved form belongs to *W. laurina* HBK., probably collected in Colombia; I have not seen the type but have consulted Macbride's photograph of it. The Cundinamarca plants were considered by Kunth as *W. ovata* Cav., but D. Don described them as a new species, *W. Kunthiana*, because of their broad and large, sometimes nearly round, leaves marked by prominent veins. Another broad leaved form is *W. calothyrsa* Diels the leaves of which are regularly obovate, commonly obtuse and sometimes attenuate, often resembing and interprading with *W. lamprophylla;* it is widely distributed along the West Cordillera of Colombia, from Popayán to Albán. In Venezuela, *W. Moritzii* Engler designates a variety slightly different from *laurina* with shorter, ovate-elliptical or ovoid and probably more coriaceous leaves. This character becomes more prominent in Venezuela, where in the Gran Sabana (Steyermark) the most sclerophyllous form is found.

In the light of these facts the following varieties are recognized, although their taxonomical value is limited:

Weinmannia Balbisiana HBK.,
var. **lamprophylla** (Diels) Cuatr., nov. comb.

W. lamprophylla Diels, Engl. Bot. Jahrb. **37**: 412, 1906.

Leaves lanceolate, acute, serrate. This Colombian variety resembles most closely the typical form of the species. Schultes 3277 (F), Killip 7898 (US).

Weinmannia Balbisiana HBK., var. **laurina** (HBK.) Cuatr., nov. comb.

W. laurina HBK., N. Gen. Sp. Pl. **6**: 51, 1823.

Leaves broad, lanceolate, crenate, glabrous. Cuatrecasas, Schultes et Smith 12821, 12576 (F, US), Cuatrecasas et Garcia B. 10233 (F, US), Perez A. et Cuatrecasas 6312, 6046 (US, F), Dryander 2811 (US), Killip and Smith 19766 (US).

Weinmannia Balbisiana HBK., var. **subovata** Cuatr., nov. var.

Folia mediocria ovato-elliptica basi cuneata apice subite attenuata acuta vel obtusa.

Type: COLOMBIA, Comisaría del Caquetá, Cordillera Oriental: Quebrada del rio Hacha, abajo de Gabinete, 2100–2250 met. alt., 23-III-40 colect. J. Cuatrecasas 8562 (F). Another collection 8714 A (sterile shade plant with larger leaves). This variety closely related to the next one.

Weinmannia Balbisiana HBK., var. **Moritzii** (Engler) Cuatr., nov. comb.

W. Moritzii Engler, Pflanzenfam. 2. Aufl., **18a**: 252, 1930.

Leaves ovate, lanceolate, serrate. This character cited by Engler is very distinct in the sterile branchlets of Moritz 1141 (US) but the leaves of the fertile branchlet are more crenate resembling the other Venezuelan specimens: Jahn 710, 996, 1074 (US), Lasser 342 (US), Delgado 342 (US), Moritz 1141, type (US).

Weinmannia Balbisiana HBK.,
var. **Kunthiana** (D. Don) Cuatr., nov. comb.

W. Kunthiana D. Don, Edinb. Phil. Journ. **9**: 85, 1830.

Leaves large, ovate, elliptical to nearly suborbiculate, attenuate or obtuse with cuneate base and short petiole, glabrous; axis of inflorescence hairy. This variety has the largest leaves among those found in the Oriental Cordillera and has its distribution center in Cundinamarca. Mutis 2070 (US) 2076 (US), Gutierrez & Jaramillo 167 (US, F), Garcia B. & Jaramillo 10427 (US, F).

Weinmannia Balbisiana HBK.,
var. **calothyrsa** (Diels) Cuatr., nov. comb.

W. calothyrsa Diels, Engl. Bot. Jahrb. **37**: 413, 1906.

A variety represented mainly in the West Cordillera on the slopes of the Cauca river valley. It is characterized by having markedly obovate, large, generally obtuse and with crenate-serrate leaves. Lehmann 5418 (US), 1066, 1065 and 1064 (NY), Triana 1851–54 (US), Pennell et Killip 8055 (US), Duque J. 45 (US, F), Perez Arbelaez et Cuatrecasas 6059 (US, F), Jameson (Ecuador) (US 534631), Killip et Garcia 33724 (US), Dryander 2084, 2069 (US), Cuatrecasas 18344, 18416, 21958, 22243, 22437 and 23765 (Valle, F).

Weinmannia Balbisiana HBK., var. **Bangiana** Cuatr., nov. var.

Folia obovato elliptica longe petiolata. Pseudo-racemi folia 2–3 plo longiores. Capsulae pedicellique longiores (capsula 4.5 mm. longa). Glaberrima.

Type: BOLIVIA, Unduavi, sept. 1894 colect. Bang 2484 (US, NY).

WEINMANNIA AURICULIFERA Hier., Engl. Bot. Jahrb. **20**, Beibl. 49: 22, 1895.

W. Cuatrecasasii Macbride, Field Mus. N. H. Bot. Ser. **13**: p. 2 (3): 1051, 1938.
W. heterophylla HBK. (non R. et P.), Nov. Gen. et. Sp. Pl. **6**: 53, 1823.

After comparing my material from Popayan with typical material of *W. heterophylla* HBK. (from the Mutis collection) I am of the opinion that the differences noted by Hieronymus (loc. cit.) are too insignificant to warrant specific segregation.

Killip and Smith (Bull. Torr. Bot. Cl. **56**: 362 and 364) attributed winged petioles (ternate leaves) to the Mutis plants, whereas the Hieronymus species lacks such. It is true that the plants from the Popayan region show this character, but the width of the petiole wing varies in the Mutis plants and other specimens. The stipules likewise show no difference, because in all plants seen they are pubescent underneath. Pubescence also is variable, as for instance, a specimen from Dep. Caldas (Tomas 2038) is more pubescent than others, but hardly worthy of taxonomic recognition. The fruits of this specimen are small, while the other specimens lack fruits. The leaves of the Cauca and Valle plants are more coriaceous than those of the Mutis plants.

Specimens examined: H. Tomas 2038 (Dep. Caldas) (US), Pennell et Killip 8198 (Dep. Cauca) (US), P. Arbelaez et Cuatr. 6313 (Dep. Cauca) (US), Dugand et Jaramillo 3060 (Valle) (US), Mutis 2074, 2080 (US).

Weinmannia silvatica Engler, var. **occidentalis** Cuatr., nov. var.

Quam typo differt folia minora 15–30 mm. long., 12–24 mm. lata, ovato-elliptica vel orbiculato elliptica. Inflorescentiae breviores, 2–3 cm. longae, congestiores. Omnis planta magis hirsutula.

Type: COLOMBIA, Dep. del Valle; Cordillera Occidental, Los Farallones, vertiente NW, Quebrada de Ramos, páramos 3150–3200 m. alt., 31-VII-1946 colect. J. Cuatrecasas 21842. "Hoja verde oscura brillante haz, verde clara envés. Cápsula rojiza. (F.). Additional specimen examined: Id. locality. Los Farallones extremo N, vertiente NW entre Alto del Buey y Quebrada de Ramos, 3450-3350 met., 12-X-1944 colect. J. Cuatrecasas 18030 (F).

Weinmannia ovalis R. et P., var. **elliptica** (HBK.) Cuatr., nov. comb.
W. elliptica HBK., Nov. Gen. Sp. Pl. **6**: 41 (1823).

Weinmannia ovalis R. et P.,
var. **penicillata** (Cuatr.) Cuatr., nov. comb.
W. penicillata Cuatr., Caldasia n° 2: 13, 1941.

Weinmannia ovalis R. et P., var. **petiolata** Cuatr., nov. var.

Folia anguste elliptica vel obovato-elliptica, basi angustato-cuneata petiolo 5–8 mm. longo.

Type: COLOMBIA, Dep. del Valle, Cordillera occidental, Los Farallones, Quebrada de Las Nieves, lomas parameras sobre la mina El Diamante, 3000–3120 met. alt., 31-VII-1946 colect. J. Cuatrecasas 21820. "Arbol 10 met. Ramas erguidas formando superficie superior plana. Hoja coriácea, verde clara, brillante. Estambres blancos. Pétalos rosados." (F). Additional specimens: The same locality Cuatrecasas 21817. "Arbol 10 met. Ramas erguidas, superficie superior plana. Hoja coriácea verde clara muy brillante. Estambres blancos. Pétalos rosados." The larger leaves are sterile branches of the inferior side of the tree. The same region on the Alto del Buey, páramos 3500–3600 met. alt., 11-X-1944 colect. J. Cuatrecasas 17904. "Arbol 10 met. Hoja coriácea, lisa, brillante, verde intenso haz, pálida envés. Capullos rosados. Pétalos y filamentos blancos." Same locality 12-X-1944 colect. J. Cuatrecasas 17975, sterile young plant with some leaves trifoliate. Same locality 12-X-1944 colect. J. Cuatrecasas 17975-A, sterile. Same locality 12-X-1944 colect. J. Cuatrecasas 18034. "Arbol. Hoja coriácea plana, verde con bordes rojizos. Cápsula roja."

This new variety is a typical plant of the high Andean vegetation in the West Cordillera; its leaves are intermediate between those of *elliptica* and *penicillata,* but it differs from both by its longer petiole.

WEINMANNIA SORBIFOLIA HBK., Nov. Gen. et Sp. Pl. **6**: 57, 1823.

Killip and Smith (Bull. Torrey Bot. Cl. **56**: 366, 1929) correctly suspected that this species is synonymous with *W. crenata* Presl. (1831) and *W. Spruceana* Engl. (1869–70). After seeing the rich material sent on loan I am convinced of the specific identity of these epithets as well as of my *W. sclerophylla.* On the other hand, after seeing the type,

W. cinerea R. et P. apparently is a different species having elliptical leaflets of special texture.

W. sorbifolia ranges from Peru to Venezuela and, as Killip and Smith have noticed, the size, width, and serration of the leaflets change within the area occupied by it. I am herewith proposing several varieties which are linked by many intermediate forms. The typical variety (*sorbifolia*) embraces forms with narrow, short leaflets with serrate teeth and more or less pubescent inflorescences; the other forms I included in var. *crenata*. Var. *sclerophylla* Cuatr. certainly represents a form with strongly veined, large leaflets, glabrous branchlets and longer pedicels.

Weinmannia sorbifolia HBK., var. **typica,** Cuatr.

The following collections belong here: Mutis 633, 2066 (US), Buchtien 759, 1664 (NY, W), Rusby 536 (NY), Garganta 822 (F), Killip & Smith 19797, 20050 (NY, US), Steinbach 8246 (US), Jahn 914, 915 (US).

Weinmannia sorbifolia HBK., var. **crenata** (Presl.) Cuatr., nov. comb.
W. crenata Presl., Rel. Haenk. **2:** 51, 1831.
W. Spruceana Engler, Pflanzenfam. 2. Auf., **18a:** 252, 1930.

Bang. 1988, 311 (US, NY), Jahn 93 (US), Garganta 690 (F), Cuatrecasas 185, 8117, 10078 (US), Killip et Smith 18041, 19461, 23226, 24770, 19516, 18887, 19461, 19305 (US, NY), Killip et Smith (sterile latifolia form) 16109, 16745, 19305, Rusby et Pennell 1057, fma., 544 (NY), Rusby 535 (US), Buchtien 7313, 5415, 1663, 298 (US, NY), Ariste Joseph B-107, B-105 (US), Krukoff 11053, 10620 (NY), Tate 867 (NY), Andre 909 (NY, US), Lehmann 4980 (NY), Garcia B. 11824 (US), Espinosa 679 (NY), Toro 349 (NY), Spruce 5845 (type *W. Spruceana*) (NY).

Weinmannia sorbifolia HBK.,
var. **sclerophylla** (Cuatr.) Cuatr., nov. comb.
W. sclerophylla Cuatr., Caldasia n. **2:** 18, 1941.
Cuatrecasas 23490, Herrera 2634 (US) fma.

Weinmannia sorbifolia HBK., var. **caliana** (Cuatr.) Cuatr., nov. comb.
W. crenata var. *caliana* Cuatr., Ciencia **1:** 253, 1940.
Duque 1555 (US), Killip et Smith 15105, 19809 (US, NY).

WEINMANNIA TOLIMENSIS Cuatr., Trab. Mus. Cienc. Nat. Madrid, ser. Bot. **26:** 18, fig. 10 y 11, 1933.

In the Central Cordillera, in the region of Barragán and vicinity, I collected many specimens which agree with the typical form (Cuatrecasas 20244, 20375, 20408, 20416, 20424 and 20597 (Valle, F)). One collection found south in the same Cordillera is distinguished by larger leaflets, a character better seen in sterile branches. I am proposing it as a new variety; it could also be a hybrid with *W. pubescens*.

Weinmannia tolimensis, var. **latifoliolata** Cuatr., nov. var.

Folia coriacea, 7–12 cm. longa, 4–8 juga. Foliola elliptica, 2–3.4 cm.

longa, 10–20 cm. lata, supra plus minusve pilosa, nitida et rugulosobullata.

Type: COLOMBIA, Dep. del Cauca; Cordillera Central vertiente occidental Cabeceras del río Palo: Quebrada de Santo Domingo, bosquecillo subiendo al páramo, 2950–3150 m. alt., 13-XII-1944 colect. J. Cuatrecasas 19256. "Arbol. Hoja verde pálida." (F.).

Weinmannia Trianae Weddell, var. **sulcata** (Engler) Cuatr., nov. comb. *W. sulcata* Engler, Pflanzfam., 2. Aufl., **18a**: 254, 1930.

I have seen and collected rich material of this group, but regard Engler's species as a variety lacking wings on the foliar rachis, as this character is variable. The Ecuador plants have commonly narrower leaflets.

AQUIFOLIACEAE

Ilex suprema Cuatr., sp. nov.

Arbuscula usque ad 8 met. alt. Rami ramulique conferti subverticillati terminalibus erectis, cortice griseo obtuse striato glabro, foliorum cicatricibus prominentibus, juveniles striato-angulati fuscescentes densissime foliosi.

Folia rigido-coriacea, lamina 10–20 mm. long. x 6–15 mm. lata obovata apice rotundata basi cuneata in petiolum 1–2 mm. longum crassum attenuata, utrinque glaberrima viridis nitidissima; margine subincrassata violacea supra partem mediam crenato-serrata; supra costa impressa reliquis nerviis subobsoletis; infra nervo medio valde prominenti basim versus incrassato, nervis lateralibus prominulis 5–6 paribus ascendentibus marginem versus cum nervulis anastomosantibus. Folia juvenilia terminalia rosulata fusca. Stipulae triangulares usque 1 mm. longae.

Flores pentameri vel hexameri plerumque solitarii vel cyma 2–3 floribus, axillis foliorum vel bractearum, subterminalibus vel pseudoapicalibus dispositi. Bracteae spatulatae circa 5 mm. longae. Pedunculi 4–5 mm. longi bibracteolati bracteolis triangulari-linearibus acutis. Calyx explanatus 4–5 mm. latus lobis obtusissimis glaber margine minutissime ciliolatus. Corolla rotata petalis ellipticis 4–5 mm. longis, 3 mm. latis, albis apice violaceo-punctatis, basi 1 mm. coalitis. Stamina masculorum florum quam petala breviora filamentis 1.5 mm. long., antheris 1 mm. long. Ovarium florum feminei 3 mm. diam. stigmate crasso obtuse conico. Corolla feminorum florum paulo minor, staminodia tenuibus. Drupa nigra 8 mm. diam., 5 vel raro 6 pyrenis.

Type: COLOMBIA, Departamento del Valle. Cordillera Occidental: Los Farallones, vertiente oriental en el filo de la Cordillera debajo de La Torre: La Laguna, 3500–3550 met. alt. 1-VIII-1946 colect. J. Cuatrecasas 21894. "Arbol 8 met. alt. Hoja coriácea, rígida, verde, brillante, generalmente con borde violáceo. Corola blanca con una mancha violácea en cada punta." (F.)

Cotypes: COLOMBIA, Departamento del Valle. Cordillera Occidental: Los Farallones, Quebrada de Las Nieves, lomas parameras sobre la mina El Diamante, 3000–3120 met. alt., 31-VII-1946 colect. J.

Cuatrecasas 21830. "Arbol. Hoja coriácea, rígida, verde brillante oscura. Frutos negruzcos, 8 mm. diam." (F.)

Id. id. Los Farallones, filo de la Cordillera, matorrales de páramo, en el cerro La Torre, 3750 met. alt. 10-X-1944 colect. J. Cuatrecasas 17864. "Arbolito. Hoja coriácea, muy rígida, verde con el borde y ápice pardusco. Rosetones terminales parduscos. Cáliz verde con márgen pardusco. Corola blanca."

This species is closely related to *I. uniflora* Benth., but distinguished from it by shorter petioles, smaller densely placed leaves which are nearly imbricate at the end of the branchlets; veins prominent on the lower side of the leaves; and short floral peduncles. The size of its leaves and its general growth form sufficiently distinguish *I. suprema* from the different forms of *I. uniflora;* especially the straight terminal branchlets covered by obovate, sub-imbricate leaves borne on short petioles differ greatly from those of *I. uniflora* var. *paramensis* Cuatr. and var. *pastoensis* Loes.

Ilex uniflora Benth., var. **paramensis** Cuatr., nov. var.

Folia quam typo minora, ovato elliptica vel obovata vel elliptico-oblonga, vulgo 8–22 mm. longa x 7–14 mm. lata copiosa ramis congesta.

Type: COLOMBIA, Departamento del Valle, Cordillera Central: Hoya del río Bugalagrande: Barragán: Páramo de Bavaya, Corrales 3550–3400 m. alt., 10-IV-1946 colect. J. Cuatrecasas 20565. "Arbol 12 met. Corteza delgada, frágil, sublisa, escamosa, bris sepia claro o gris verdosa, sección verdoso pálida. Hoja verde oscura brillante haz, las terminales violáceas." (F.)

Cotypes: COLOMBIA, Dep. del Valle, Cordillera Central: Hoya del río Tuluá: entre Las Vegas y Ribera, 3450–3300 met. alt., 25-III-1946 colect. J. Cuatrecasas 20426. "Arbol 4 met. de ramas tortuosas. Hoja coriácea, verde brillante haz. Cáliz verde con puntas violáceas. Corola interiormente blanca, por fuera violácea." (F.)

My plant 20565-A, also collected in the Paramo de Bavaya, is a form resembling somewhat *I. myricoides*, but because of its strongly coriaceous and more obovate leaves, this number, like 20565, must be referred to *I. uniflora.* In the Central Cordillera of Colombia, I also found typical *I. myricoides* var. *polyphylla* (Benth.) Loes. (nos 19166, 20960), which differs greatly with its slender elliptical leaves. Hybridization between these two related species is very probable.

My collection 18823 from the sources of Río Palo in the paramos of Quebrada del López, Central Cordillera (3300–3350 m. alt.), is typical *I. uniflora* Benth. var. *pitayensis* Loes., collected in a region regarded as the classic locality. It agrees with fragments of the type (Hartweg 1196 from Pitayó) represented in the Chicago Natural History Museum Herbarium (F). Lehmann slightly different no. 5570 is the type of variety *pastoensis* Loes.

My plants from the Páramo de Bavaya have smaller and more crowded leaves than does the type of *I. uniflora* with its shorter floral and fructiferous pedicels, preponderance of single flowers and dense foliage. This form apparently arose in the páramos and, for this reason, I named it *paramensis.* The typical form and v. *pitayensis* are found in the forests below the páramos.

Ilex spinulosa Cuatr., sp. nov.

Arbor usque ad 10 met. alt. Rami ascendenti cortice fusco-ruguloso plus minusve cicatricoso. Ramuli hirsutissimi ad ramorum terminationem copiosi conferti erecti valde denseque foliosi.

Folia coriacea breviter petiolata. Petiolus crassus, 1–2 mm. longus. Lamina ovata vel ovato elliptica basi rotundata apice parum attenuata spinuloso-cuspidata, margine paulo revoluta apicem versus denticulato serrulata, 2–4 dentibus acutis spinulosis utroque latere; supra atroviridis nitida praeter nervo medio hirsutulo glabra vel parce hirta; infra virido-palidior crispo hirsutula nervo medio crasso valde prominenti, lateralibus 4–5 pro latere conspicuis marginem versus cum nervulis anastomosantibus. Stipulae minusculae, incrassatae triangulari acuminatae 1 mm. long.

Flores tetrameri solitarii axillares. Pedunculi articulati brevissime bracteolati, masculi teneres glabri striolulati 5–6 mm. longi, feminei breviores crassiores (3–4 mm. long.) pilosiusculi. Sepala basi coalita, mascula anguste triangularia 0.8 mm. longa, feminea late triangularia acuta, 1.5 mm. longa. Corolla alba rotata, petalis tantum basi coalitis, elliptiea glabra feminea 3.5–4 mm. longix x 2 mm. latis, mascula 2–2.5 mm. longa, 1.2 mm. latis. Stamina masculorum florum quam petala breviora antheris ovato oblongis crassiusculis. Flores feminei antheris brevioribus teneribus sterilibus, ovario crasso glabro 4-sulcato, 2 mm. longo; stigmate globoso capitato. Drupa prematuritate ovoidea 4 mm. longa saepe 2–1 nuculis.

Type: COLOMBIA, Departamento del Valle; Cordillera Occidental: Los Farallones, filo de la cordillera, extremo N en el Alto del Buey, páramos 3500–3600 met. alt., 11-X-1944 colect. J. Cuatrecasas 17890. "Arbol. Copa compacta, arriba casi plana, verde oscura. Hoja coriácea, rígida, verde oscura haz, verde amarillenta envés. Corola blanca." (F.)

Cotypes: COLOMBIA, Departamento del Valle, Cordillera Occidental: Los Farallones, id. id. Alto del Buey, 3500–3600 met. alt., 11-X-1944 colect. J. Cuatrecasas 17929. "Arbol. Remaje denso. Hoja coriácea, rígida, verde oscura brillante haz. Corola blanca." (F.)

COLOMBIA, Departamento del Valle. En id. id. Los Farallones, filo de la Cordillera en el Alto del Buey, 3300 met. alt., 2-VIII-1946 colect. J. Cuatrecasas 21915. "Arbol. Hoja verde oscura semibrillante haz, verde claro envés. Cáliz verde pálido. Corola blanca."

The trees belonging to this species are densely branched with the ends of the branches turning upwards and forming a nearly flat upper surface. This species differs greatly from all others in the genus and is especially characterized by its ovoid, coriaceous leaves, which are hairy underneath and provided with spinulose teeth and apex, by densely hirsute branchlets, solitary flowers, the capitate stigma, and a fruit with only one or two stones.

Ilex colombiana Cuatr., sp. nov.

Frutex usque 2 met. alta ramis erectis griseis cicatricoso tuberculatis glabris. Ramuli valde tuberculati cinerei glabri densissime subimbricato folioso; valde juniores sparsis crassiusculis pilis muniti infra petiolo insertionem tuberculati hirsutuli.

Folia coriacea rigida petiolo 0.5–0.8 mm. long. glabro. Lamina in vivo patens, late ovata basi rotundata apice atenuata acuta utrinque glabra supra atroviridis subnitida, infra pallidior laevis epunctato excavata; margine subtus incrassata, supra medium 1 dente utroque latere, vel laevis; nervo medio supra impresso subtus eminenti, infra nerviis lateralibus 2–3, curvato ascendentibus obsoletis vel inconspicuis, 3.5–6.5 mm. longa, 2.5–5 mm. lata. Stipulae lanceolatae crassiusculae acutae plus minusve squamuloso hirsutae.

FIG. 2. *Ilex colombiana* Cuatr.

Flores tetrameri, masculi solitarii axillares breviter pedunculati, pedicelli glabri 2–3 mm. longi breviter bibracteolati, bracteolis decussatis 0.5–0.8 mm. long. late ovato-acutis squamuloso-pilosis. Calyx glaberrimus 2 mm. long. sepala ½ interiore coalita, ovata apice obtusa. Petala late ovato-elliptica obtusa basi coalita, glaberrima intus alba extus precipue violacea 4 mm. long., 3 mm. lata. Stamina breviora, glabra. Antherae crasse ellipticae, 0.8 mm. longae. Ovarium minutum, stigmato nullo. Flores feminei petalis majoribus 4.5–5 mm. longis x 4 mm. latis, staminibus brevioribus, antheris teneribus, ovario crasso, stigmate crasso tetraquetro capitato.

Fructus prematuritate 6–7 mm. long. rotundato oblongus, 4-locularis.

Type: COLOMBIA: Departamento del Cauca; Cordillera Central, vertiente occidental, Cabeceras del río Palo, quebrada del río López; Alto del Duende, matorrales y bosquecillo de páramo 3300–3350 met. alt., 1-XII-1944 colect. J. Cuatrecasas 18836. "Frútex erguido. Ramas verticales, rígidas, cubiertas de hojas subimbricadas. Corola blanca, por fuera más menos lilácea." (F.)

Cotype: Id. id. Cabaceras del río Páez: Páramos entre Perro Muerto y la Laguna del Paez, 3550–3450 met. alt., colect. 4-2III-1944 J. Cuatrecasas 19016 A. "Frútex 2 met. Hoja coriácea, rígida, verde oscura semibrillante haz. Corola blanca, exteriormente viólaceo purpúrea." (F.)

The structure of this *Ilex* is very interesting, for it is an ericoid bush resembling a *Vaccinium* or *Disterigma* with erect branches covered with nearly imbricate, rigid and acute leaves. It is closely related to two Bolivian species, *I. microphylla* Hook. and *I. minimifolia* Loes., particularly to the latter because of its very small leaves. But *I. colombiana* differs from them by its glabrous, acute leaves; lanceolate, acute, thick stipules covered by some scaly hairs; young branchlets at first covered by scarce, thick hairs and a hairy protuberance below the insertion of the petiole, but later completely glabrous; calyx glabrous with smooth edges; and lower side of leaves without depressions.

Ilex pernervata Cuatr., sp. nov.

Arbor mediocris. Rami plus minus striati cortice fusco griseo ruguloso breviter tuberculato. Ramuli terminales fusci striolati glabri.

Folia alterna coriacea petiolata glabra. Petiolus 4–11 mm. longus rigidus erectus supra canaliculatus infra rotundatus. Lamina 3.5–11 cm. longa x 2.3–6 cm. lata rigida obovato-elliptica, vel elliptico-oblonga basim attenuata, cuneata vel rotundata, apice rotundata vel parum attenuata obtusa; supra viridis vel atroviridis nitida nervatione impressa; infra epunctata pallido viridis nervo medio valde prominenti nervis lateralibus utrinque latere 6–9 angulo obtuso satis eminentibus merginem versus elevato reticulatis reliquis nervulis laxam reticulum prominulum vel obsoletum formantibus; margine-minute serrulato-crenata. Stipulae anguste triangulares acutae glabrae, 1 mm. longae.

Inflorescentiae in cymis trifloribus vel unifloribus axillares pedunculo circa 1 cm. longo glabro, bracteolis decussatis minutis triangularibus 1 mm. longis, pedicellis 2–4 mm. longis crassiusculus glabris. Flores hexameri, raro heptameri feminei sepalis late orbicularibus glabris tantum basi coalitis 3 mm. long., 3 mm. lat.; corolla alba rotate glabra 8–10 mm. diam., petalis elliptici oblongis obtusis laevibus 5 mm. long., 2 mm. latis, ¼ inferiore coalitis; staminibus petalis dimidio brevioribus, planis; antheris brevibus teneribus sterilibus, ovario crasso glabro stigmatibus incrassato-capitatis valde evolutis. Drupa 10–12 mm. diam. 6–7 nuculis, in sicco 6–7 profunde sulcata.

Type: COLOMBIA, Comisaría del Putumayo: alta cuenca del río Putumayo, en el Valle de Sibundoy, extremo E, junto a San Francisco, 2200 met. alt. 1-I-1941 colect. J. Cuatrecasas 11566. "Arbol; corola blanca." (F.)

Cotypes: COLOMBIA, Departamento del Valle: Los Farallones, filo de la Cordillera Occidental, extremo N., en el cerro Alto del Buey,

páramos 3500–3600 met. alt., 12-X-1944 colect. J. Cuatrecasas 17986. "Arbusto con ramas torcidas. Hoja rígida, coriácea, fuertemente reticulada, brillante en el haz, verde amarillenta envés." (F.)

Id. id. Los Farallones, vert. NW: Quebrada del Ratón-Mina El Diamante, 2950–3000 met. alt., 30-VII-1946 colect J. Cuatrecasas 21758. "Arbol. Hoja membranáceo crasiuscula, verde oscura brillante haz, verde clara envés. Capullos verde claros." (F.)

I. pernervata differs from the other Andean species and from its closest relative, *I. Karstenii* Loes., by the following characters: whole plant glabrous; leaves obovate or elliptic, rigid, their lower side prominently veined more than in *I. nervosa* (Tr. et Pl.); inflorescences axillary, cymose with simple flowers or groups of three; flowers generally hexamerous or heptamerous; fruit large with deep grooves when dry; the leaves of very young branchlets as in collection bo. 21758, are less rigid and have less prominent nerves though their lower leaves always agree with the type.

Ilex gabinetensis Cuatr., sp. nov.

Arbor 8–10 met. alta. Rami striati fusci juveniles pubescentes deinde glabrati.

Folia coriacea alterna petiolata. Petiolus 10–16 mm. longus plus minusve striolatus infra glaber supra canaliculatus puberulus. Lamina elliptica vel elliptico-oblonga basi rotundata apice parum attenuata obtusa vel rotundata; margine plana profunde obtuseque serrato-crenata, 4–9 cm. longa x 2–4.5 cm. lata; supra atroviridis nitida sparsis pilis munita vel glabra praeter nervo medio sulcato tomentuloso; infra juvenilibus foliis pubescens, deinde sparsis pilis munita, satis nigro punctulata, nervo medio valde eminenti secundariis 9–12 utroque latere, patentibus satis prominentibus marginem versus reticulato obsoletis inter eos nervulis minus prominulis late reticulatis. Stipulae lineari-lanceolatae usque 1.5 mm. long. pilosae deciduae.

Inflorescentiae femineae, cymae dichotomae pedunculatae solitariae axillares. Pedunculi glabri 14–22 mm. longi, ramulis 2–3-plo furcatis brevioribus sparse pilosis vel glabris, bracteolis linaeribus vel triangulari-linearibus 1–3 mm. long. Pedicelli brevissimi floribus subsessilibus. Flores tetrameri. Calyx usque 1 mm. long., sepalis ovato rotundis margine parce ciliatus vel levibus. Corolla alba 3.5 mm. diam., sepalis ovato oblongis basi coalitis 2.5 mm. longis, 1.5 mm. latis. Stamina sterilia tenera sepala breviora. Stigma breviter capitatum. Ovarium 4-loculare. Drupa immatura brevis 4-pyrenis.

Type: COLOMBIA, Comisaría del Caquetá; Cordillera Oriental, sobre el filo divisorio: Gabinete, bosque 2300–2450 met. alt., 23–III-1940 colect. J. Cuatrecasas 8500. (F.)

Related to *I. crassifolia* Hook. and *I. crassifolioides* Loes., this species is distinguished from them by its membranaceous-coriaceous leaves with crenate margin, its inflorescence, pubescence and the small flowers.

Ilex yurumanguinis Cuatr., sp. nov.

Arbor mediocris ramis extremis divaricatis pendulis densissime floribundis cortice griseo glabro plus minusve cicatricosa fisso.

Folia simplicia alterna coriacea petiolata. Petiolus brevis, 5–10 mm.

longus glaber incrassatus. Lamina rigida obovato-elliptica vel elliptico-oblonga, basim versus attenuato-cuneata, apice subite attenuata subapiculata vel obtusa, 9–15 cm. long x 4.4–7.5 cm. lata; margine repando serrata dentibus 3–8 mm. distantibus subinconspicuis sed minute acumino spinuloso munitis; supra glabra atroviridis costa bene signata nervis secundariis, 7–9 paribus, obsoletis; infra pallido-viridis depresso-punctata costa valde elevata nervis secundariis ascendentibus marginem versus satis curvatis anastomosantibus prominentibus, venulis anastomosatis reticulo obsoleto. Stipulae brevissimae, triangulares apice acute spinulosae.

Inflorescentiae masculae axillares glomeratae. Flores masculi in breves cymas trifloras (vel 2–1 flores) copiosas congestas aggregatae,

FIG. 3. *Ilex yurumanguinis* Cuatr.

axillares, insertionem rami tuberculo elevato. Bractae lanceolatae 1.5–2 mm. longae. Pedunculi 2–5 mm. longi glabri. Pedicelli 1–1.5 mm. longi. Bracteolae ovatae minutissimae. Calyx explanatus 1.5–2 mm. diam. obtuse 4-lobatus glaber albido lutescens. Petala 4, elliptica 2.5 mm. long. x 1.5 mm. lata glabra alba. Stamina petala aequilonga, filamentis albis, antheris luteis ovatis. Ovarium conicum octo-striatum muticum. Stigmate nullo.

Type: COLOMBIA, Departamento del Valle. Costa del Pacífico: Río Yurumanguí, Veneral, bosques en la Quebrada del Zancudo 10–50 met. alt. 10-II-1944 colect. J. Cuatrecasas 16156. "Arbol con ramas hojosas péndulas, divaricadas, largamente cubiertas de glomérulos de flores. Hoja coriácea, verde oscura haz, verdoso amarillento envés. Cáliz blanco amarillento. Pétalos blancos. Filamentos blancos. Anteras amarillas." (F.)

Close to *I. Laureola* Tr. and *I. affinis* Gard., this species differs from them by having rather obovate-elliptical leaves with a cuneate base, and an obsolete crenate margin bearing separate minute and spiny teeth directed upwards. The inflorescences are reduced, glomerate and denser than in *I. affinis;* the flowers are smaller and the peduncles are more slender than in the other two.

Ilex nayana Cuatr., sp. nov.

Arbor grandis. Ramuli griseo fusci, juveniles viridi rubescentes glabri sublaeves.

Folia membranaceo-coriacea alterna petiolata. Petiolus angustus 5–10 mm. long. Lamina elliptico oblonga utrinque attenuata basi plerumque cuneata apice acutiuscula, vel acuminata vel raro obtusa; 6–10 cm. longa, 2–4 cm. lata; margine laevis; supra viridis laevis glabra nervo medio impresso; infra pallidior costa elevata nervis secundariis arcuato ascendentibus et venulis minus prominulis. Stipulae minutissimae lineares, 1 mm. longae.

Inflorescentiae in paniculis axillaribus racemosis vel pseudo-umbellatis 1–2 cm. longis, 3-multifloribus vel raro unifloribus, pedunculis 5–10 mm. long. tenuibus rubescens parce et minutissime pilosulis. Bractae parvissimae lineares. Pedicelli teneres brevissimis pilis 2–4 mm. longi. Flores masculi, calyce explanato 1.5–2 mm. lato margine obtuse sublobato, ciliato. Petala 4 elliptica vel elliptico-oblonga 2 mm. longa, supra infra partem mediam minutissime papilloso pilosa. Stamina 4 petala subaequilonga. Ovarium conicum sterile muticum.

Type: COLOMBIA, Departamento del Valle. Costa del Pacífico, río Naya: brazo Ají, orilla derecha en Calle Larga, 1–4 met. alt., 28-II-1944 colect. J. Cuatrecasas 14286. "Gran árbol; tallo color canela." (F.)

This species resembles *I. Laureola* Tr. et Pl. and *I. amygdalifolia* Rusby, but is well characterized by its slender leaves, thin and rigid branchlets of the inflorescences and pedicels, and by tetramerous flowers.

Ilex bullata Cuatr., sp. nov.

Arbor mediocris. Rami divaricati cortice griseo ruguloso minute pilosulo.

Folia simplicia alterna coriacea petiolata. Petiolus 3–5 mm. long. robustus minutissime tomentulosus. Lamina obovata vel obovato-elliptica vel elliptica, basi cuneato-attenuata apice obtuse acuminata vel acuta, 3–6 cm. longa x 1.5–3 cm. lata, margine valde revoluta, supra griseo-atroviridis opaca irregulariter sparse hirta; subtus pallido-viridis punctata hirsutula minutis pilis valde acutis rigidis patentibus munita; costa supra valde depressa, infra prominenti, 2–3 nervis secundariis utroque latere, inter costam et nervos laterales supra depressos subtus elevatis lamina valde bullata, aspectu testudinis.

Inflorescentiae uniflorae, umbellato-glomeratae axillis foliorum. Pedunculi articulati tenues set rigidi ciliati 6–10 mm. longi. Calyx tetramerus parce puberulus vel glabratus sepalis obtusis, explanatus 2 mm. diam. Fructus minutissime puberulus 4 loculis, 4 pyrenis, orbiculato-oblongus inmaturus 2.5 x 3 mm., stigmate capitato adpresso.

Type: COLOMBIA, Departamento del Valle, Cordillera Occidental, vertiente occidental: Hoya del río Dígua, río San Juan, abajo de Queremal a la derecha del río, entre km. 52 y 53, 19-III-1946 colect. J. Cuatrecasas 23878. "Arbol. Hoja cóncava y abollada, verde plomizo oscuro en el haz, verde claro en el envés." (F.)

This species is very different from all other Colombian species of *Ilex* and possibly from all in the genus, because the special structure of its leaves which are concave and greatly swollen between the nerves; these are very depressed above and very prominent below.

Ilex caliana Cuatr., sp. nov.

Arbor 30 metralis. Caulis validus cortice granulato-ruguloso pallido-bruneo fragili. Rami robusti cortice griseo vel luteolo-griseo ruguloso-striato dense et minute tomentuloso hirsutulo.

Folia alterna rigide coriacea fragilia petiolata. Petiolus robustus teretiusculus supra sulcatus in sicco plus minusve rugulosus sub lente minute hirsutulus 10–15 mm. longus. Lamina oblonga elliptico-lanceolata vel lanceolata basi attenuata vel cuneiformis, apice longe attenuata vel acuminata, acuta vel obtusiuscula, 11–20 cm. long. x 3.5–5 cm. lata; margine tenuissime recurvata, repando crenato-serrulata dentibus minutissimis spinulosis; supra grisaceo-viridis opaca glabra, praeter basim praecipue in nervo minutus sparsis pilis munita, costa elevata nervis secundariis obsoletis; infra pallidior viridus depresso punctata, costa valde eminenti nervis secundariis conspicuis marginem versus et nervulis in laxo obsoleto reticulo anastomosatis, glabra vel basi parcissimis minutis pilis. Stipulae minutae lineari-triangulares acutae vel spinulosae, 3–4 mm. longae.

Flores (cymulae uniflores) in foliorum axillis dense fasciculati. Rami insertione punctum tuberculo elevato bracteato-fimbriato. Bractae ovato acutiusculae vel acutae plus minusve puberulae. Pedunculi fructiferi 4–7 mm. longi, erecti sparse hirsutulo-tomentulosi supra vel infra partem mediam articulati apice incrassati. Calyx 4 sepala ovata obtusa, explanatus 3.5 mm. diam. Fructi (immaturi?) luteolo-virides 6 mm. diam. stigmate depresso subdiscoideo 4 loculis, 4 pyrenis.

Type: COLOMBIA, Departamento del Valle: Cordillera Occidental, vertiente oriental, Hoya del río Cali, Pichindé: Alto de Las Brisas, matorral y bosque residual, 2160 met. alt. 27-X-1944 colect. J. Cuatrecasas 18281. "Arbol 30 met. alt. Tallo 60 cm. diam., ramificado en los ¼ superiores. Corteza ruguloso granulosa, en el aspecto general uniforme color pardo claro, grisáceo; sección ocráceo pardusca clara con zumo que ensucia la madera; dificilmente separable, fragmentándose. Madera dura, casi blanca, fina. Hoja coriácea, rígida, frágil, verde grisáceo mate haz, verde mas claro envés. Frutos verdoso amarillentos." (F.)

Ilex caliana is a very well characterized species because of the form, size and consistency of its leaves and the structure of its inflorescence. *I. laurina* HBK., very similar in regard to leaves and inflorescences, is its closest related species, but the plant from the Hoya del rio Cali differs radically from it on account of the minute

hirsute tomentum covering its branchlets; the peduncles and petioles are also hirsute, as is the base of the leaves.

Ilex mucronulata Cuatr., sp. nov.

Arbor 20 met. alta. Ramuli grisei vel griseo-fusci, glabri terminales angulati.

Folia flexuose coriacea alterna petiolata. Petiolus rigidus subteres supra sulcatus 6–10 mm. longus. Lamina elliptica vel obovato-elliptica, vel ovoidea-elliptica basi apiceque attenuata apice plerumque apiculata extremis minute calloso-mucronulata; 6–12 cm. longa x 3–6 cm. lata; margine angustissime revoluta laevis; utrinque pallido viridis opaca in sicco fusca, glabra nervo medio supra sulcatus infra valde elevatis secundariis 8–10 utroque latere marginem versus anastomosantibus, supra obsoletis subtus prominulis, venulis reticulatis subtus obsoletis. Stipulae minutissime callosae lineari acuti.

Inflorescentiae axillares, cymulis 3–1 floribus, pedunculis rigidis patentibus 5–8 mm. longis glabris, pedicellis glabris teneribus rigidus 4–5 mm. long. Bracteae crassiusculae ovato lanceolatae acutae, minutissimae (1 mm. long.). Bracteolae triangulares minutissimae. Calyx fructiferus discoideus obtusissime 4 sinuatolobatus, margine laevis vel minute ciliatus, 3 mm. diametro. Fructus in vivo 1 cm. diam. glaber laevis atroruber, in sicco 8 mm. diam. stigmate conico depresso subquadrisulcato, 4 nuculis triquetris 6 mm. long. x 2 mm. latis.

Type: COLOMBIA, Departamento del Valle. Costa del Pacífico; Bahía de Buenaventura: Quebrada de San Joaquín, 0–10 met. alt. 22-II-1946 colect. J. Cuatrecasas 19938. "Arbol grande. Hoja coriácea, delgada, rígida, flexible, verde pálida mate. Bayas rojas oscuras, 1 cm. diam." (F.).

Closely related to *I. amygdalifolia* Rusby from Peru, this species differs in having thinner and cuneate leaves; Rusby's plant also has a minute terminal mucron. In *I. mucronulata* the inflorescences are simpler and shorter, generally three-flowered. The fruits are much larger than in the Peruvian species.

Ilex scandens Cuatr., sp. nov.

Frutex scandens. Rami grisei rugulosi. Ramuli griseo-brunei sublaeves glabri extremis angulatis.

Folia coriacea alterna. Petiolus rigidus 8–12 mm. longus subteres glaber supra canaliculatus. Lamina ovoideo-elliptica utrinque attenuata basi cuneata apice apiculata obtusiuscula, 7–13.5 cm. longa x 2.5–5.5. cm. lata; margine plana crenato serrata dentibus saepe minutissime acute mucronatis; supra obscure luteolo viridula glabra nervis obsoletis; subtus pallidior glabra costa valida elevata nervis secundariis 7–8 utroque latere curvato ascendentibus prominentibus, reliquis nervis manifestis reticulatis. Stipulae minute lineari-lanceolatae crassiusculae deciduae, 1 mm. long.

Inflorescentiae axillares racemosae, 2 cm. longae, plerumque 10 floribus. Pedunculi laeves glabri. Bracteolae ovatae vel ovato-lanceolatae margine ± laceratae, 0.5–1.5 mm. long. Pedicelli 0.3 mm. longi glabri, bracteolati. Flores pentameri, masculi. Sepala ovata 1 mm.

long. margine lacerato-ciliata. Petala elliptica aequilonga (in prefloratione). Antherae ovatae apiculato-mucronatae. Ovarium subconicum striatum parce apiculatum sed stigmate nullo.

Type: COLOMBIA, Departamento del Valle. Cordillera Occidental, vertiente oriental; Hoya del río, Cali, Pichindé: Alto de Las Brisas, matorral y bosque residual, 2160 met. alt. 27-X-1944 colect. J. Cuatrecasas 18271. "Gran bejuco. Hoja coriácea, verde amarillenta oscura. Capullos verdoso amarillento claros." (F.)

The leaves of this species are very similar to those of *I. Karstenii* Loes. However, the inflorescences of *I. scandens* are not glomerate but larger, racemose, axillary and solitary. Unlike all other known species of this genus, *I. scandens* is a climbing plant.

SABIACEAE

Meliosma andina Cuatr., sp. nov.

Arbor grandis. Caulis cortice crasso ruguloso brunneo. Ramuli griseo-brunnei juvenili puberuli badi.

Folia simplicia alterna coriacea rigida pallido viridia. Petiolus 6–8 mm. long. pubescenti-hirsutus supra sulcatus. Lamina obovato-elliptica oblonga vel elliptico-lanceolata, 4.5–8 cm. long. x 16–25 mm. lat. margine integra plana; supra glabra praeter nervum medium sulcatum strigosum, reliqua minute elevato reticulata; subtus costa crassa prominenti dense strigoso hirsuta, nervis secundariis 6–8 utroque latere plus minusve eminentibus strigosis, reliqua elevato nervoso-reticulata sparse strigosa, et minutis pilis capitatis munitis in sicco supra griseo vel viridi-brunnea, infra badi.

Paniculae terminales copiosae agglomeratae 8–15 cm. long., basi foliosae. Pedunculi rhachis ramulique dense tomentoso hirsuti. Flores in ultimis ramulis 3–10 mm. longis dense conglomeratae sessiles vel subsessiles. Bracteola inferior ovato-acuta 8 mm. longa hirsutula, 2 bracteolae ad calycem adpressae suborbiculatae, 6–7 mm. margine ciliatae. Sepala pallida ovata vel orbiculata circa 1 mm. diam. margine ciliata. Petala exteriora alba concava glabra suborbicularia 2 mm. diam., staminodia ferentia. Petala interna elliptico oblonga integra 1.2 mm. longa. Antherarum loculi divaricati. Ovarium glabrum. Stylus brevissimus.

Type: COLOMBIA, Dep. del Valle, Cordillera Occidental: Hoya del rio Cali, vert. izquierda del rio Pichinde, arriba de Tareas 2400 m. alt. 25-VII-1946 colect. J. Cuatrecasas 21723. "Arbol grande. Corteza gruesa rugosa parda, sección pardo rojiza. Madera dura rojiza. Hoja coriácea, verde clara. Capullos verde ocráceos. Corola blanco ocrácea." (F.)

Although closely related to *M. brasiliensis* Urban, *M. andina* differs from it especially by its small leaves which have a different texture, by the terminal and more elaborate inflorescences and by the smaller and very glomerate flowers.

Meliosma ellipticifolia Cuatr., sp. nov.

Arbor grandis, caulis usque ad 50 cm. diam. Ramuli glabri griseo-brunnei.

Folia simplicia alterna rigida coriacea glabra. Petiolus 6–10 mm. longus supra canaliculatus basi incrassatus plus minusve granulosus glaber. Lamina oblongo-elliptica 7–12 cm. long. x 3.5–5 cm. lata basi attenuata apice parum angustata obtusa vel rotundata margine integerrima plana vel in sicco anguste revoluta; supra viridis nervo medio valde manifesto subdepresso, secundaribus obsoletis reliquis elevato minuteque reticulatis, in sicco sparse minuteque albo-punctata; infra costa crassa eminenti, 9–11 nervis lateralibus tenuibus angulo obtuso marginem versus ascendentibus arcuatus anastomosatis, reliquis venulis minutum elevatum reticulum formantibus.

Paniculae subterminales axillares erectae 8–12 cm. longae rhachi subglabra ramulis brevibus parce pubescentibus. Pedicelli 1–2 mm. longi pubescenti. Bracteolae 1–2, ovato-acutae ciliatae. Sepala alba ovato-rotundata 1.5–2 mm. long. margine ciliata. Petala exteriora tria, alba orbiculata concava 2.5–3 mm. diam. glabra, cum staminodia coalita. Petala interiora linearia 1.2 mm. long., bicuspidata cum stamine (2 mm. longa) coalita. Ovarium glabrum. Stylus brevis. Stigma puntiforme.

Type: COLOMBIA, Dep. del Valle: Cordillera Occidental, Hoya del rio Calima. El Cairo, entre Darién y Mediacanoa, 1650–1750 m. alt. 7-I-1943, J. Cuatrecasas 13903. "Gran árbol. Tallo hasta 50 cm. diam. Flores blancas. Madera robusta, buena para construcción." (F.)

Closely related to *M. brasiliensis*, this species is different because of its more elliptical and completely glabrous leaves which are more prominently reticulate and have marked secundary nerves. It differs also by having glabrous or puberulent inflorescences, larger and pedicellate flowers and interior bifid petals.

Meliosma glossophylla Cuatr., sp. nov.

Arbor grandis, plerumque 20 met. alt. caule 25 cm. diam., cortice rubescenti brunneo vel griseo. Rami ramulique glabri badi rubescenti plus minusve cicatricosi.

Folia simplicia alterna coriacea rigida fragilia glaberrima nitida. Petiolus 1.5–2.5 cm. longus robustus glaber badius supra plano-sulcatus basim incrassatus. Lamina obscure viridis oblongo-lanceolata valde elongata, 18–35 cm. longa x 3.2–6.0 cm. lat., basi cuneata apice attenuata acuta; margine integerrima plana vel tenuiter recurvata; supra nervo medio amplo manifesto lateralibus et reticulo obsoletis; infra costa crassa prominenti, nervis secundaribus filiformibus eminentibus 18–26 utroque latere angulo obtuso marginem versus anastomosatis, reliquis nervis venulisque minute elevato-reticulatis.

Panicula fructifera terminalis basi foliosa. Ramuli fructiferi rubro-brunnei plerumque 20 cm. longi glabri. Pedunculi fructiferi incrassati 2 mm. longi vel pseudopedunculi longiori. Calyx persistens. Sepala ovata 2 mm. long. margine ciliata.

Drupae subglobosae in vivo 2 cm. diam. immaturae pallido-virides. In sicco subpyriformae endocarpio lutescenti, subcarinato alveolato rugoso, basim angustato, lignoso pariete 2.5 mm. crasso.

Type: COLOMBIA, Dep. del Valle, Cordillera Occidental, Hoya del río Cali, sobre Pichindé. Alto de las Brisas, matorral y bosque residual, 2160 m. alt. 27-X-1944 colect. J. Cuatrecasas 18270. "Arbol 20 met.

alt. Tallo 25 cm. diam. Corteza pardo rosada o gris, sección anaranjada zumosa, fácilmente separable. Madera dura, rojiza en el centro, hacia afuera rosada o rosado ocrácea. Hoja coriácea, rígida, verde amarillenta oscura haz, clara en el envés. Drupas 2 cm. diam., inmaturas amarillo verdoso claras." (D.)

Cotype: Id. id., río Pichindé, entre Los Cárpatos y El Olivo 2025 met. alt. 26-VII-1946 colect. J. Cuatrecasas 21732. "Gran árbol. Hoja coriácea, rígida, frágil, verde oscura brillante, frutos inmaturos 2 cm." (F.)

This species is very characteristic and different from others because of its long, narrow, oblong, coriaceous leaves.

Meliosma occidentalis Cuatr., sp. nov.

Arbor 20 m. alta caule 25 cm. diam. cortice rubro peridermi viridi-ochraceo rugoso obtecto. Rami extus griseus cortice infra peridermus aurantio-rubro (in vivo).

Folia simplicia membranaceo-coriacea alterna petiolata. Petiolus 1.5–2 cm. longus puberulus supra sulcatus basi longe incrassatus. Lamina atroviridis obovato-alliptica attenuata, basi cuneata apice acute cuspidata, 10–20 cm. longa, 4.5–9 cm. lata, margine integra plana vel levissime revoluta; supra in sicco viridi-brunnea vel brunnea tacto leviter scabrida sparsis pilis adpressis munitis junioribus leviter minute elevato reticulata nervo medio leteralibusque adpresse hirsutis; infra in sicco brunnea nervo medio valde prominenti, lateralibusque 12 paribus ascendentibus argute adpresse hirsutis reliqua elevato reticulata plus minus strigoso hirsuta.

Paniculae subterminales axillares rhachi ramulisque laxe divaricatis dense pubescenti-strigosis. Flores sessiles vel subsessiles aliquis bracteis ovato-acutis ciliatus 0.3–0.4 mm. longis. Sepala 5 pallido-viridia orbicularia margine ciliata 1–1.2 mm. longa. Petala exteriora 3 cochleata decidua glabra sed margine plus minusve minutissime ciliolata, orbicularia inaequilonga circa 2.5 mm. diam. cum staminodia coalita. Petala interiora lineari-lanceolata 2 mm. longa glabra. Stamina sterilia dua petala interiora basi coalita filamenta tenuia 0.6 mm. longa anteriferarum lobulae ovato-globosae 0.5 mm. long. connectivo cupuliformi 0.6–0.7 mm. diam. Ovarium ovato acuminatum glabrum. Stylus elongatus filiformis. Stigma punctiforme.

Drupae pyriformes pallido virides 25 mm. long. x 18–20 mm. latae, pericarpio 2–3 mm. crasso plus minusve translucido, acidulo; endocarpio lignoso valde duro basi longe abrupte angustato rubescenti intus viridulo. Epispermium membranosum. Embryo grandis albus.

Type: COLOMBIA, Departamento del Valle; Cordillera Occidental vert. Occidental, Hoya del río Anchicayá bosques junto a la Quebrada de El Retiro, 230–260 m. alt. 13-X-1943 colect. J. Cuatrecasas 15279. (F.)

This species is close to *M. panamensis* Standley which I also found in Colombia (n° 14148, Guayabel, rio Micay, Dep. Cauca, Costal del Pacifico, 20 m. alt.). *M. occidentalis* is distinguished by its smaller entire leaves, which are strigose, especially on the veins below. By comparison *M. panamensis* has more elongate leaves, which are long attenuate towards the base and much longer peduncles in the fruiting stage.

ICACINACEAE

Citronella colombiana Cuatr., sp. nov.

Arbor 8 met. alta. Rami curvato-penduli. Ramuli viridi-brunnei laevi juventute pubescentes deinde glabri.

Folia alterna simplicia coriacea. Petiolus 1–1.5 cm. longus robustus levis supra sulcatus pubescens deinde plus minus glabratus. Lamina crassiuscule coriacea 13–23 cm. longa x 7–12 cm. lata, ovata apice angustata breviter cuspidata basi cuneata margine membranacea integra plana vel levissime revoluta nervis secundariis 5 utroque latere angulo acuto ascendentibus marginem versus anastomosatis; supra griseo-viridis nitida sparsis crispis pilis munita costa et nervis secundariis depresso signatis; infra crispo-pubescens opaca viridis costa crassa valde eminenti nervis secundariis satis prominentibus venulis elevato reticulatis saepe ad nervulorum axillas punctato-foveolata.

Inflorescentiae extra-axillares 10–14 cm. longae, pedunculo (2–3 cm. longo) rhachique crispo-hirsutulis ramulis patentibus usque ad 7 mm. longos bracteis ovato-lanceolatis 1.5 mm. longis hirsutis. Floralibus bracteolae brevissimae, ovatae hirsutulae ciliatae. Flores sessiles. Calyx pallido-viridis sepala ovata parce crispo-hirtula 2–2.5 mm. longa. Petata viridulo-albida elliptico-oblonga apice abrupte angustata acuminata 3.5–4 mm. longa, 2 mm. lata prefloratione acumine inflexa. Filamenta basim versus dilatata plana 2 mm. longa. Antherae oblongae, basi emarginatae 0.8 mm. longae. Ovarium glabrum 1.5 mm. long. Stylus simplex. Stigma capitato-lobatum. Fructus ellipticus 1 cm. longus.

Type: COLOMBIA, Dept. de Vallo; Cordillera Occidental: Hoya del río Cali vertiente izquierda del río Pichindé, El Cairo, 2100–2180 m. alt., colect. 6-VIII-1946, J. Cuatrecasas 21959. "Arbolito 8 met. Ramas curvas péndulas en el extremo. Hoja subcoriácea gruesa, verde grisácea brillante haz, mate envés. Cáliz verde claro. Corola blanco verdosa." (F.)

Although related to *C. incarum* (Macbr.) Howard, the leaves of this species are always pubescent on the lower side and more cuneate at the basis, the secundary veins branch off at a more acute angle; the inflorescences are larger and hirsute; the flowers are larger and the petals longer (3.5 mm.).

Citronella sucumbiensis Cuatr., sp. nov.

Arbuscula. Ramusculi terminales pubescentes brunneo-viriduli.

Folia simplicia alterna membranacea. Petiolus 10–15 mm. longus tenuis sparse pubescens. Lamina viridis late elliptica vel ovato-elliptica 11–17 cm. longa, 6.5–9.5 cm. lata, basi subrotundata vel obtuse cuneata apice abrupte cuspidata; angustissime cartilagineo marginata, margine integra plana; supra glabra praeter nervum medium parcissime pilis munitum, costa anguste signata nervis secundariis paulum apparentibus; infra costa eminenti 6–8 paribus nervis secundariis prominentibus obtuse ascendentibus marginem versus arcuatis anastomosatis, sparsissimis pilis strigosis munitis, reliqua glabra venulis reticulatis.

Inflorescentiae oppositifoliae 8–14 cm. longae. Rhachis strigoso-hirsutulis ramulis usque ad 7 mm. long. Bracteae ovato-acutae hirsutulae 0.8 mm. longae. Bracteolae florales ovatae obtusae ciliatae imbricatae. Flores sessiles. Sepala viridia ovato-acutiuscula 1–1.2 mm. long. dorso parce hirtula margine lacerato ciliata. Petala viridulo-albida elliptico-oblonga 2 mm. long., 1 mm. lata, dorso apicem versus minutissime sparse puberula. Stamina breviora filamento plano basim versus dilatato. Antherae ellipticae basi cordatae. Ovarium glabrum. Stylus brevis. Stigma 1–3 lobatum.

Type: COLOMBIA, Comisaría del Putumayo, selva higrófila del río San Miguel (o rio Sucumbíos) en el afluente izquierda Quebrada de la Hormiga, 290 m. alt. Colect. 16-X-1940, J. Cuatrecasas 11106. "Arbusto; corola blanco verdosa." (F.)

Close to *C. incarum* (Macbr.) Howard, *C. sucumbiensis* can be distinguished by the following characters: membranaceous, elliptical leaves with a broad base, divaricate secundary veins and without pores; inflorescences opposite to the leaves and glabrous ovary.

Citronella silvatica Cuatr., sp. nov.

Arbor 20 met. alta caulis 50 cm. diam. cortice rugoso fisso brunneo sectione pallido-brunneo 6 mm. Lignum durum album. Ramuli terminales viriduli sparse minutissime pilosi denique glabri.

Folia alterna simplicia rigide coriacea. Petiolus 1 cm. long. valde robustus parcissime pubescens vel glaber. Lamina 17–24 cm. longa x 8–14 cm. lata elliptica vel elliptico-oblonga basi subrotundata apice attenuata acuta, margine membranacea integra plana sed levissime recurvata utroque latere 5 nervis secundariis arcuato ascendentibus marginem versus anastomosantibus; supra atroviridis nitida glabra costa et nervis lateralibus depresso notatis; infra pallido viridis glabra sed sublente minutissime granulosa et sparsissimis pilis munita, costa crassa prominenti nervis lateralibus satis elevatis, nervulis eminentis laxe reticulatis.

Inflorescentiae extra-axillares vel oppositifoliae 8–15 cm. longae, rhachis sparse pilosula, ramulis tenuibus curvatis ad 10 mm. long, pubescentibus, bracteolis ovatis acutis hirtulis 1–1.2 mm. longis. Flores sessiles. Sepala viridia parce pilosula margine ciliata ovata. Petala elliptico oblonga concava apicem versus angustata obtusiuscula viridulo-albida, glabra, 2.2 mm. long., 1.2–1.4 mm. lata. Stamina 1.5 mm. longa filamento plano basim versus ampliato antherae oblongae basi emarginatae. Ovarium pilosum. Stylus brevis. Stigma capitatum.

Type: COLOMBIA, Dep. del Valle; Cordillera Occidental; Hoya del río Sanquininí, lado izquierdo, La Laguna, bosques, 1250–1400 m. alt., 10-X-1943, colect. J. Cuatrecasas 15402. "Arbol 20 m. alt. Tallo 50 cm. diam. Corteza pardusca rugoso hendida, sección pardo clara 6 mm. Madera blanca dura. Hoja coriácea, verde oscura haz, claro envés. Hojas tiernas verde amarillento pálidas y ramitas terminales verdes. Cáliz verde. Corola blanco verdosa." (F.)

Close to *C. costaricensis* (Donn. Sm.) Howard, *C. silvatica* is very different from the other species of the genus because of its pubescent ovary, hermaphrodite flowers, large elliptical leaves, extra-axillary inflorescences, and the shape and size of the floral parts.

Calatola sanquininensis Cuatr., sp. nov.

Arbor 10 met. alta. Caulis 25 cm. diam. Cortice griseo-brunneo sectione brunneo deinde caeruleo. Lignum in vivo album, deinde atrocyanum. Ramuli brunnei juveniles pubescentes demum glabri.

Folia simplicia alterna coriacea. Petiolus 2–3.5 cm. longus in juvenilibus pubescens denique glaber supra plus minusve sulcatus. Lamina obovato oblonga basim versus attenuata apice subito angustata obtusa vel acuta vel breviter cuspidata, 17–24 cm. longa 5.5–9 cm. lata margine integra plana; supra atroviridis glabra vel minutis sparsis pilis munita, subtus viridis sparsis minutis pilis munita vel glabra nervo medio crasso eminenti, secundariis 8–11 utroque latere arcuatis ascendentibus marginem versus obsolete anastomosatis, venulis in laxo reticulo vix signato.

Spicula mascula suboppositifolia 10–18 cm. longa pendula pallido-viridia crassa in vivo 5–6 mm. in sicco tenuiora et scabra. Rhachis crassa (1.5–2 mm. lat.) sparse puberula. Bracteae lineari lanceolatae acutissimae 1.5–1.6 mm. longae extus pubescentes in sicco rigidae. Flores pallido virides. Calyx 2.5 mm. diam. extus pubescens sepalis ovato-lanceolatis basi coalitis. Petala ovata acutiuscula 2 mm. longa 1.5 mm. lata glabra sed dorso parcissimis pillis. Flores feminei et fructus ignoti.

Type: COLOMBIA, Dep. del Valle, Cordillera Occidental, Hoya del río Sanquininí, La Laguna bosques 1400 met. alt. 20-XII-1943 colect. J. Cuatrecasas 15690. "Arbol 10 m. alt., tallo 25 cm. diam. Corteza pardo grisácea agrietada, sección 1 cm. lat., parda que azulea al aire. Madera blanca que se vuelve azul oscuro al aire. Hoja coriácea, verde oscuro haz, más claro envés. Amentos colgantes verde claros." (F.)

This species is closely related to *C. columbiana* Sleumer but differs from it by having narrower, nearly glabrous leaves which are obovate oblong and broadest in the upper third. The male inflorescences are larger and have longer bracteoles and larger flowers; in the dry spikelets the sepals and bracts are stiff and rough if touched. The calyx lobules are ovate-lanceolate and deeply cut, whereas those of *C. columbiana* are ovate and shallow.

I compared this new species with abundant and complete material of *C. columbiana*, which I collected in the type locality and which agrees perfectly with the type specimen (Duque J., n° 1310). *Calatola columbiana* has broad, abruptly attenuate leaves, which are less pubescent on the upper side than on the lower; male katkins which are hirsute-pubescent, narrower, and smooth; and smaller flowers (bracts 1.2 mm. long, calyx 2 mm. diam., petals 2 mm. long x 1.5 mm. wide, suborbicular). Although the fruit of *C. sanquininensis* is unknown, the characters mentioned are sufficient to define it as a distinct species.

DICHAPETALACEAE

Tapura colombiana Cuatr., sp. nov.

Arbor 8 met. alta. Cortex badius. Lignum lutescens. Ramuli cinerei rugulosi parce pubescentes denique glabri.

Folia coriacea simplicia alterna. Petiolus crassiusculus parce puberulus deinde glaber, 7–10 mm. longus. Lamina obovato-oblonga basi

cuneata abrupte angustata acuminata 9–16 cm. longa, 3–6.5 cm. lata, acumine 6–10 mm. longo, utrinque glabra luteolo-viridis nitida levis, in sicco sparse obsolete granulata, margine integra laevis anguste revoluta supra costa et nervis secundariis obsolete elevatis infra costa crassa, 6–7 nervis secundariis utroque latere notatis inferioribus ascendentibus medianis et superioribus patentibus, marginem versus anastomosatis, reliquis nervis obsoletis laxe reticulatis.

Flores ad tertiam superiorem petioli 10–16 dense glomerati, pedunculo crasso fere 2 mm. longo pubescenti-velutino, bractis valde minoribus pubescentibus. Calyx luteolo-velutinus 5–6 mm. longus subcampanulatus profunde 5-lobatus lobulis inaequalibus 2.5–3.5 mm. longis ovalibus obtusiusculis intus glabris apicem versus puberulentis. Petala lutescentia cum staminibus in tubo coalita, 3–5 lobis vulgo 4 lobis ovatis brevibus liberis vix inaequalibus exunguiculatis geniculatis valde inflexis emarginatis, 1–2 mm. long, fauce dense lanata reliqua glabra. Stamina antherifera vulgo 4 (vel 2–3) quam petala paulo breviora filamentis brevibus. Ovarium valde hirsutum. Styli tres liberi hirsuti, 2.5–3 mm. longi, stigmatibus filiformibus glabris.

Type: COLOMBIA: Dep. del Valle, extremo norte región de Cartago: Cordillera Occidental, cerro Alto de Mira, entre Tabor (o Las Brisas) y Carrizales, 2100–2350 m. alt., bosques. 23-X-1946 colect. J. Cuatrecasas 22470. "Arbol 8 met. Tallo 20 cm. diam. Corteza sepia, sección blanco ocrácea. Madera dura amarillenta. Hoja coriácea verde amarillenta, lisa, brillante haz y envés. Sépalos y pétalos amarillo claro." (F).

Tapura colombiana is well characterized by the size and obovate-elongate shape of its leaves, the size of its flowers, the densely velvety pedicels and calyces, the long andropetalous tube, the 4 petalous tips (otherwise 3–5) of similar size, 4 anthers (otherwise 3–2) with short, hairy filaments and by its 3 hirsute, completely free, styles. This species definitely approaches the genus *Stephanopodium* from which it differs also by its 3 styles.

It is close to *T. guianensis* which has longer flowers, longer fused and slender petals, longer filaments and less hirsute calyces. Similarly, *T. coriacea* Macbr. has long fused petals with geniculate lobes, but differs by its unequal petals, smaller leaves and flowers. So far only one species of this genus has been described from Colombia: *T. bullata* Standley, collected by Haught in Santander and quite different from *T. colombiana*.

Tapura costata Cuatr., sp. nov.

Arbor 20 metralis. Caulis robustus profunde sulcatus et elevato costatus contortus, cortice brunneo-griseo. Ramuli cortice striolato ruguloso glabro.

Folia simplicia alterna coriacea. Petiolus 6–9 mm. long. robustus rugulosus glaber. Lamina subelliptico-oblonga, 10–15 cm. longa, 3.5–5 cm. lata, basim versus paulo angustata abrupte cuneata, apice abrupte obtusque cuspidata, margine integra plana vel leviter revoluta, utrinque pallido-viridis glabra in sicco minute tuberculata, supra costa crasse signata nervis secundariis obsoletis, subtus costa eminenti nervis lateralibus 6–7 utroque latere arcuato ascendentibus bene signatis, reliquis venis laxe reticulatis.

Flores ad tertiam superiorem petioli dense capituliformis aggregatae. Pedicelli brevissimi. Bracteolae valde breves ovatae pubescentes. Alabastra globosa. Sepala inaequalia extus pubescentia. Petala in alabastris 5, basi tubo coalita ovato-lanceolata tria paulo majora. Anthrae 5 in alabastro fere aequilatis. Styli 3. Flores evoluti ignoti.

Types: COLOMBIA, Dept. del Valle. Río Calima (región del Choco) La Esperanza, 10 met. alt., 7-III-1944 colect. J. Cuatrecasas 16746. "Arbol 20 met. alt. Tallo 30 cm. diam., acanalado y torcido en toda su longitud, estriboso en la base. Corteza escamosa, gris, sección pardusca. Madera ocrácea, oscura. Hoja coriácea, rígida, verde claro. Capullo blanco amarillento." (F).

This species is easily distinguished by its trunk which is marked by longitudinal grooves and ribs and is twisted, a fact indicated by its common name "costillo" (rib-tree). Other important characters are the granulose surface of the leaves, the inflorescence, and its three styles. As the flowers of the available specimens are immature and the andropetalous tube is not yet developed, this species is tentatively referred to *Tapura*.

Dichapetalum nervatum Cuatr., sp. nov.

Arbor. Ramuli terminales divaricati plus minusve penduli badi sparse pubescenti-hirti.

Folia simplicia alterna subcoriacea pallido viridia. Petiolus 4–5 mm. longus, crassus sparse hirtus. Lamina 8–13 cm. longa x 4.5–5.5 cm. lata subovato-oblonga basi attenuata inaequilatere truncata vel rotundata apice angustata longe cuspidata; margine integra plana; supra costa hirsutula et nervis secundariis impressis, nervulis reticulatis plus minusve notatis inter se superficie sub-bullata vetusta glabrescens; infra costa valde prominenti 8–9 utroque latere nervis secundariis valde elevatis ascendentibus arcuatis prope marginem anastomosantibus nervulis eminentibus reticulatis, utrinque hirta, sparsis longis pilis munita. Stipulae lineari-lanceolatae, elongatae longe hirsutae deciduae.

Inflorescentiae cymosi-paniculatae divaricatae pedunculo ramisque teneribus longe villoso-hirtis. Bracteae bracteolaeque subulatae 4–1.5 mm. longae villoso-hirtulae. Pedicelli graciles circa 2–3 mm. long. villoso-hirtuli. Alabastra ante anthesim 2 mm. long., subglobosa hirto-sericea. Sepala 5 ovata intus glabra. Petala 5 in alabastro obovata basi unguiculata profunde bipartita libera. Stamina alternantia antheris reniformibus connectivo ampliato. Receptaculi squamae planae 5, petala oppositae. Ovarium villosum. Stylus simplex valde crispo villosus apice trifurcatus, stigmatibus capitatis. Fructus ovato-oblongus 2.5–3 cm. longus dense vellutino-tomentosus viridi lutescens.

Type: COLOMBIA, Dep. del Valle: Costa del Pacífico, bosques del río Yurumanguí cerca de Veneral, en la Cuchilla de Cebolladito, 50 met. alt. 31-I-1944 colect. J. Cuatrecasas 15833. "Arbol. Flor blanco amarillenta. Hoja semicóriácea, verde clara." (F.).

This species is characterized by its subcoriaceous leaves and the prominent veins on their under side. The tips of the branchlets are covered with rather long, fine, spreading hairs, whereas the leaves are sparsely covered with long rigid hairs, as are the inflorescence and calyx. On the basis of its venation, this species is very close to

Symphyllanthus plicatus Gleason, but differs from it by the above characters. (The tomentum on the branchlets and inflorescence of *S. plicatus* is dense and short and its leaves lack long hairs on their upper side.)

CELASTRACEAE

Perrottetia caliensis Cuatr., sp. nov.

Arbor 15 met. alta. Ramorum terminationes penduli. Ramuli fusci sparse lenticelati sub-laeves glaberrimi.

Folia simplicia alterna membranacea. Petiolus 1 cm. long. lateribus luteolo puberulentus supra sulcatus. Lamina oblongo lanceolata basi cuneato-rotundata apice attenuata longe acuminata, 12–15 cm. longa, 4–5.5 cm. lata, acumine 15–18 mm. longo, margine minutissime repando denticulata; supra atroviridis nitens glabra nervo medio signato secundariis subobsoletis; infra viridis costa nervisque secundariis (8–10 utroque latere) parce luteolo tomentulosis reliqua glabra laxe reticulata. Stipulae submembranaceae viridi-badiae lanceolatae rectae acutae 12 mm. longae, 3 mm. latae, glabrea denique deciduae.

Inflorescentiae axillares solitariae paniculatae 2–3.5 cm. longae axe ramulisque parce tomentulosis, ramulis brevibus. Bracteae ovato-triangulares acutae 0.5 mm. longae dorso sparsissime pilosae margine dense ciliatae, ciliis crassis. Flores feminei sessiles vel subsessiles, 1.2 mm. long., 1.8–2 mm. latae. Sepala circa 0.7 mm. longa basi coalita triangularia dorso sparse puberula margine dense crasso-ciliata luteolo viridia. Petala sub disco inserta 1 mm. longa triangularia acuta crassiuscula viridulo-luteola utrinque glabra sed apicem versus et margine dense crassiuscule ciliata persistentia. Staminodia valde breviora antheris sterilibus brevibus bilobulatis. Styli robusti 0.2–0.3 mm. longi, stigmate crasso conspicue bilobato. Discus orbicularis magnus glaber.

Inflorescentiae fructiferae usque ad 6 cm. long. et 3 cm. lat. Bacca globoso-depressa mutica vel brevissimo stylo apiculata usque 5 mm. lata glabra bilocularis tetraspermis. Semina ovalia 2 mm. long. testa externa carnosa elongato apiculata et plus minusve carinata testa interna crustacea longitudinaliter costato sulcata.

Type: COLOMBIA, Depart. Valle; Cordillera Occidental, vertiente oriental: Hoya del río Cali, río Pichindé entra Quebrada de Juntas y El Recreo, 2070–2260 m. alt. 7-VIII-1946 colect. J. Cuatrecasas 21997. "Arbol 15 met. Ramas en el extremo péndulas. Hoja membranosa, gruesa, verde oscura semibrillante en el haz. Florecitas verde amarillentas." (F).

The species of the genus *Perrottetia* differ from each other only by minute characters. *P. caliensis* is closely related to *P. quinduensis* HBK., Gen. et Sp. Pl. **7:** 75 tab. 622. According to this description, *P. caliensis* differs from *P. quinduensis* by its slightly denticulate and less tomentulose leaves, its ciliate petals, its extremely short style, fewer flowers and by the number of seeds. *P. caliensis* can be distinguished from *P. lanceolata* Karsten, Fl. Columb. **2:** 47 tab. 124, by the form and margin of the leaves, the long stipules, the petals which are glabrous on the upper side and by the sessile flowers. *P. sessiliflora* Lundell, Phytologia **1:** 451, has entire leaves and a longer style, whereas *P.*

longistylus Rose has strongly serrate leaves, larger inflorescences, pedicellate flowers and a longer style.

In the large collections examined, only flowers with reduced stamens are present. As these are surely sterile, this species is probably dioecious.

Perrottetia maxima Cuart., sp. nov.

Arbor grandis. Ramorum extremi penduli. Ramuli brunnei vel fusci glabri.

Folia simplicia alterna crasso-membranacea. Petiolus 7–8 mm. longus glaber laevis supra caniculatus. Lamina ovato oblonga basi late rotundato-cordata, apice angustata apiculata 11.5–17.5 cm. longa x 6–9 cm. lata, margine subintegra, minutissime repando denticulata, supra atroviridis in sicco brunnea glaberrima costa nervisque secundariis notatis, infra pallido viridis praeter prope nervorum axillas sparssisimis pilis glabra costa valde prominenti 9–12 paribus nervis secundariis elevatis arcuato ascendentibus nervulis laxe reticulatis conspicuis. Stipulae usque ad 15 mm. long., 5 mm. lat. ovato-lanceolatae acutae.

Inflorescentiae axillares solitariae 3–5 cm. longae, 2–3 cm. latae, fructiferae usque 8 cm. long., 10 cm. lat., ramulis patentibus divaricatis. Rhachis ramulique robusti minute luteolo tomentulosi. Bracteae ovatae acutae vel obtusiusculae 1–0.6 mm. longae. Flores sessiles vel subsessiles globulosae 0.8 mm. lat. Sepala ovato-triangularia 0.4 mm. long. extus et margine tomentulosa, pilis crassis munita. Petala ovato-triangularia acutiuscula 5–6 mm. longa extus margine apiceque tomentulosa pilis crassiusculis. Stamina 5 alterna filamentis quam petalis brevioribus antheris cordato ovatis. Stigma subsessile obscure bilobatum. Bacca rotundato-depressa nigro rubescens 4 mm. diam., 2.5 mm. alt. bilocularis tetrasperma. Semina ovoidea lateraliter compressa 1.8 mm. longa longitudinaliter ruguloso sulcata.

Type: COLOMBIA, Dep. Valle, Cordillera Occidental vertiente occidental: Hoya del río Dígua, lado izquierdo. Piedra de Moler bosques 900–1180 met. alt. 22-VIII-1943 colect. J. Cuatrecasas 15014. "Gran árbol. Ramas en el extremo péndulas, con largas panículas. Bayas rojo negras. Capullos florales ocres." (F).

Perrottetia maxima is a large tree characterized by its large, broad and generally cordate leaves. It differs from *P. caliensis* by being glabrous, bearing smaller flowers and sessile stigmas. In addition, the stamens may be shorter, whereas the fruits are definitely smaller than in *P. caliensis*.

Perrottetia distichophylla Cuatr., sp. nov.

Arbor 15 met. alta. Rami descendentes extremo pendulo. Ramuli badi vel fusci glabri vel valde juveniles parce pubescentes.

Folia simplicia alterna disticha. Petiolus 1 cm. longus glaber vel minute puberulus. Lamina membranacea lanceolato-oblonga basi late cuneata apice acuminato-caudata, 11–18 cm. long., 3–5.5 cm. lata, acumine usque ad 3 cm. longi, margine integra vel dimidia superiore parte minutissime repando denticulata, supra atroviridis glaberrima nitida costa nervisque secundariis conspicuis, infra pallido-viridis costa eminenti, nervis lateralibus 9–11 utroque latere ascendentibus marginem versus anastomosatis, reliquis nervulis laxe reticulatis,

subglabra nervis parce pulverulentis. Stipulae lineari-lanceolatae acutae 7 mm. longae, 1–1.5 mm. latae.

Inflorescentiae axillares solitariae paniculatae divaricatae teneres 7 cm. longae, 3.5 cm. latae. Rhachis ramulique sparse luteolo-tomentulosi. Bracteae ovato-triangulares fuscae puberulae 0.5 mm. long. Flores feminei minuti 1 mm. long. sessiles, viridi-luteoli. Sepala late triangularia 0.3–0.4 mm. longa basi coalita parcissime puberula margine parce ciliata. Petala 0.7 mm. longa triangularia extus pubeula margine ciliolulata pilis brevissimis crassiusculis. Stamina brevia, antheris parvis sterilibus. Ovarium glabrum. Stylus brevis glaber. Stigma bilobatum. Bacca globosa depressa 4–5 mm. diam., rubra bilocularis 4-sperma. Semina subtriquetra testa exteriora carnosa cuspidata marginata testa interna crustacea rugoso-sulcata, 1.5–2 mm.

Type: COLOMBIA, Dep. del Valle; Costa del Pacífico; río Cajambre: Barco, 5–80 met. alt. colect 29-IV-1944 J. Cuatrecasas 17243. "Arbol 15 met. Ramas inclinadas hacia abajo; ramas hojosas péndulas. Hojas dísticas, verde oscuras haz, claras en el envés. Capullos florales y flores verde amarillento claras. Bayas rojas 5 mm. lat.." (F).

Perrottetia distichophylla can easily be distinguished from other species of this genus by its narrowly oblong and long apiculate leaves, the margin of which is entire or slightly denticulate in the upper half, the nearly glabrous surface, the narrow stipules, the slender, puberulent inflorescences, the very small flowers, the very short, obtuse sepals and by the very short style.

Perrottetia calva Cuatr., sp. nov.

Arbor. Ramuli brunnei lenticelati glabri.

Folia alterna simplicia subcoriacea. Petiolus robustus 10–12 mm. longus semiteres supra sulcatus glaber. Lamina ovato-oblonga vel ovata basi rotundata apice angustata, 9.5–15 cm. longa x 4.2–7 cm. lata, margine breviter serrulato-dentata basim versus subintegra, supra atroviridis nitida glaberrima costa nervisque secundariis conspicuis, infra viridis costa eminenti nervis secundariis 10–11 utroque latere ascendentibus marginem versus arcuatis et obsolete anastomosantibus glabra vel juveniles ad nervos sparsissimis pilis. Stipulae lanceolatae acutae glabrae 15–17 mm. longae, 2.5–3 mm. latae.

Inflorescentiae axillares solitariae circa 5 cm. longae paniculatae ramis divaricatis, rhachi ramulisque glaberrimis. Bracteolae ovatae 0.5–1 mm. longae, glabrae vel margine sparse ciliatae. Flores masculi sessiles 2 mm. lat. Sepala triangularia 1 mm. long. margine brevissime sparse ciliata. Petala triangularis 1.2 mm. longa margine sparse brevi ciliata pilis crassis. Stamina quam petala breviora antheris lobulis rotundatis. Discus orbicularis magnus. Stigma sessile bilobatum.

Type: COLOMBIA, Comisaría del Putumayo; alto de la Cordillera, entre Valle de Sibundoy y Mocoa: El Portachuelo, 2600 met. alt. colect. 30-XII-1946 J. Cuatrecasas 11478. (F).

This species is undoubtedly closely related to *P. quinduensis* HBK. It differs from the latter and the other known South American species by its glabrous branchlets, leaves and inflorescences.

Follicular Dehiscence in Cruciferae

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Unlike most members of the Cruciferae, several species of this family have many-seeded indehiscent siliques or silicles. Thus, some species of Malcolmia, Matthiola, Erysimum, Sobulevskia, etc., have indehiscent pods which usually remain attached to the plant until it decays. Apparently this indehiscence results from limited development or lack of the separation tissue between replum and valves. In all species examined so far, both median sutures of the fruit (anterior and posterior) show the same anatomical structure and thus exhibit the same degree of dehiscence.

A particular form of dehiscence has been found by the author in *Leptaleum filifolium* (Willd.) DC., a dwarf, white-flowered Irano-

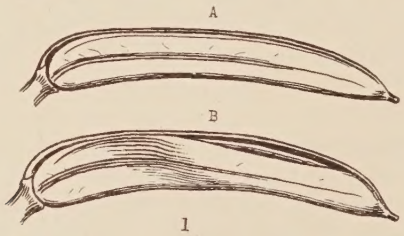

Fig. 1. Pod in natural position: A—closed, B—opened.

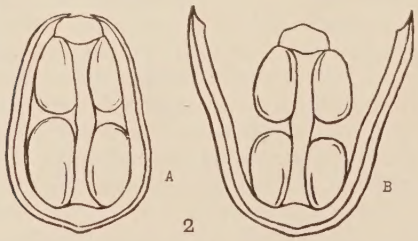

Fig. 2. Cross section of pod: A—closed, B—opened.

Turanian ephemeral, a member of the Malcolmiinae. After ripening in spring, its oblong, short-pedicelled and many-seeded pods spread horizontally and remain closed until moistened by the rains of the next winter. However, dehiscence is limited to the upper (posterior) side and resembles that of a follicle (Figs. 1 and 2). Rain drops entering the pods easily scatter the seeds. When dried up, the valves close again.

The reason for the unilateral opening of the pod lies in the anatomical difference of the two sides. As shown in Figs. 3–4, the posterior side is equipped with a separation tissue entirely lacking on the lower side. This tissue is inserted between the valves and the replum and consists

FIG. 3. Anterior suture of pod showing no structural differentiation between replum and valve.

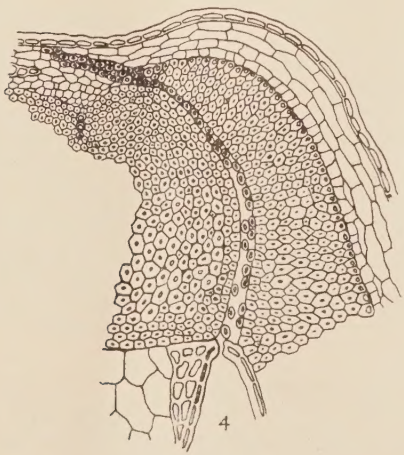

FIG. 4. Posterior suture of pod showing separation layer intercalated between replum and valve.

of one or two layers of loose parenchymatous or collenchymatous cells, round or elliptical in cross section. As these layers extend over the entire pericarp, the valves can be easily detached from the replum by the shrinking of the former. Unlike the posterior side, the anterior

one is made up of a continuous compact and lignified tissue without lines of demarcation between valves and replum.[1]

The structural characters connected with the hygrochastic movements of the valves are inadequately known in this case. They include, no doubt, a shrinkage mechanism of antagonistic cell walls as in many other hygrochastic Cruciferae, Compositae, etc. (Steinbrinck 1906, Zohary and Fahn 1941, Fahn 1947).

Hygrochastic dehiscence and the horizontal position of its pods with the opening suture directed upwards characterize *L. filifolium* as a typical ombrochorous plant. As such, it resembles species of Alyssum, Notoceras, Iberis, etc., in which hygrochastic movements of the pedicel orient the pods to an almost horizontal position most favorable for the mechanical action of rain drops on the fruit.

[1]I wish to thank Dr. A. Fahn for his kind assistance in examining the fruits and in making the drawings.

REFERENCES

Fahn, A. 1947. Physico-anatomical investigations in the dispersal apparatus of some fruits. Pal. Jour. Bot. Jer. Ser. **4:** 36–45.

Steinbrinck, C. 1906. Ueber Schrumpfungen und Kohaesionsmechanismen von Pflanzen. Biol. Centralbl. **26:** 657–677, 721–743.

Zohary, M., and **Fahn, C.** 1941. Anatomical-carpological observations in some hygrochastic plants of the oriental Flora. Pal. Jour. Bot. Jer. Ser. **2:** 125–131.